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with HIFI NEWS

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ELECTRONICS Australia

VOL. 40 No. 9 DECEMBER, 1978

Australia's largest selling electronics & hi-fi magazine

This prize-winning audio impedance meter is capable of measuring any AC impedance in the range 1 ohm to 10 megohms. Full construction details start on p62.

Contest No. 6

Here's your chance to show your understanding of electronic circuit operation! . . . You could win a Trio CS1560 15MHz oscilloscope or a B & K 2800 3½-digit DMM in the last of the Parameters/EA contests. See p60.

On the cover

Voluntary presentation announcer Enir Brunkhurst on duty in studio A of Sydney community radio station 2MBS-FM. See also page 6. The photographs were taken by Tim Lamble.

Superimposed is a picture of our new Playmaster FM-stereo tuner, designed and described by staff member Leo Simpson. See page 38.

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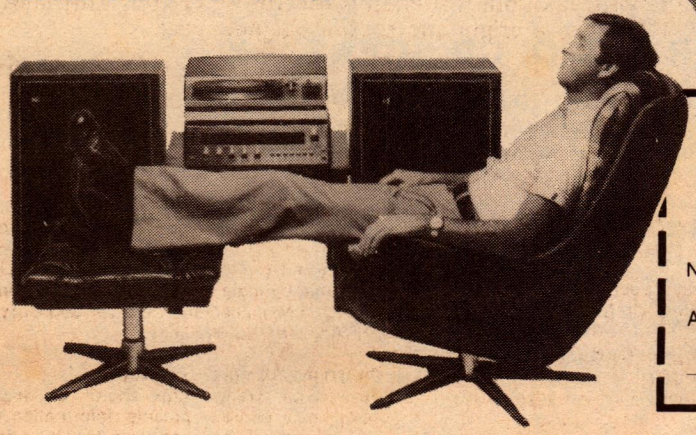

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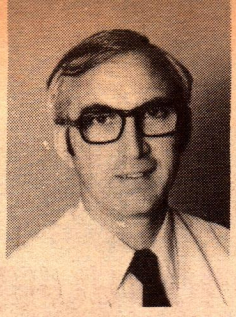

Editorial Viewpoint

The positive side of automation

A couple of weeks ago Jack Rutherford, the managing director of NS Electronics, graciously invited Neville Williams and myself to a dinner celebrating the 10th anniversary of his firm's operations in Australia. Happily we were both able to accept, and it was a very pleasant and friendly occasion. Not only that, but we had the opportunity to meet and talk with Charles E. Sporck, renowned president of NS's parent company, the dynamic National Semiconductor Corporation. Mr Sporck made a quick visit to Australia especially for the dinner, interrupting a very busy schedule.

Needless to say I was very grateful for the opportunity to meet Mr Sporck. He is one of the acknowledged leaders in the burgeoning US semiconductor industry, and the prime architect of National Semiconductor's impressive growth — it is now second largest IC manufacturer in the world, with a projected turnover this year of around $700 million. One doesn't often get the chance to meet a man with such credentials.

Like many men in similar positions of heavy responsibility, Mr Sporck has acquired a reputation for being hardnosed, humourless and rather uncommunicative. No doubt he has to be from time to time, but on this occasion I found him entirely affable and happy to explain his company's policies and his own views on a variety of topics.

It did not come as any great surprise to learn that he is a great believer in free enterprise and the benefits of technology. But it was most interesting to hear his well-reasoned and persuasive arguing that in the long term, the increased productivity caused by automation tends to increase employment rather than decrease it. He did admit, however that in the short term there could be significant localised unemployment produced — particularly in a country like Australia which tends to be technologically dependent.

Frankly I found it refreshing to hear the pro-automation arguments expressed so cogently, and in a form which was not insulting to one's intelligence. Clearly there are rational arguments in favour of automation, which need to be considered just as carefully as those against.

The point I have been trying to make in the last few of these leaders is that I believe it is high time people of goodwill representing both sides of automation got together, to discuss things realistically, honestly and calmly. Unless this is done I don't think much of our chances of solving the undoubted problems.

Problems aside, however, the festive season is coming up again — somehow this year seems to have been particularly short, doesn't it? On behalf of all of us here at EA, I would like to wish all of our readers and advertisers a Happy Christmas, and the hope that 1979 proves a bright and prosperous new year.

— Jamieson Rowe

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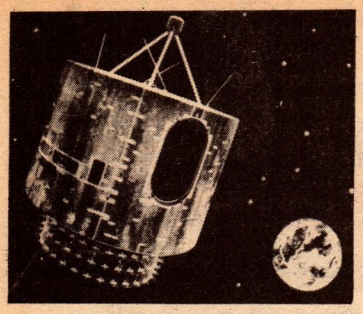


News Highlights

Look at GE's new electric car!

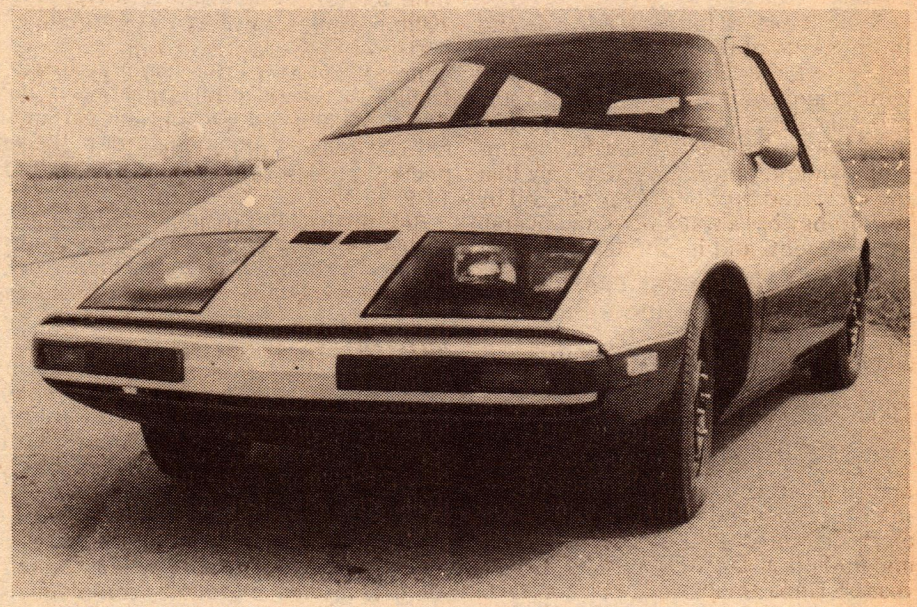
General Electric showed a new sub-compact experimental electric car at the International Electric Vehicle Exposition in October, and is now demonstrating it in cities across the USA. Called the "Centennial Electric" in honour of GE's 100th birthday, the car is described as "the electric car of today". It was designed from scratch with the goal of achieving top performance from currently available off-the-shelf components and battery systems.

"This new test vehicle was designed to provide hard data about exactly where technology stands in the formidable quest to develop a practical electric car," says Dr Roland W. Schmitt, GE vice president for corporate research and development.

The GE executive pointed out that the Centennial Electric is equipped with improved lead-acid batteries, coupled with advanced solid state controls and a highly efficient electric traction motor. The vehicle is designed primarily for stop-and-go urban driving, and has an in-town range of about 45 miles between battery charges. About 11 million of the 111 million vehicles now on US highways are second cars and delivery trucks used primarily for just this type of short-trip driving, Dr Schmitt said.

GE's front-wheel-drive electric was produced in a three-year project headed by the company's Research and Development Centre in Schenectady, NY. The car is powered by 18 six-volt, lead-acid batteries made especially for GE's Electric Vehicle Systems Operation, Salem, Va., by Globe-Union Inc., Milwaukee, Wisc. They are derived from the deep-discharge batteries now used commercially to power golf carts and forklift trucks, and can be recharged in six to eight hours by plugging them into a 220-volt electrical outlet.

Initial tests show that the vehicle has a range of 75 miles at a constant 40 miles per hour, a cruising speed of 55 mph, and a passing speed of up to 60 mph. It can accelerate from zero to 30 mph in nine seconds. By way of comparison, a conventional gasoline-powered car of similar size and weight can reach the same speed in about six seconds.



"The Centennial Electric is one of only a handful of electric vehicles that have been designed from scratch," says Dr James M. Lafferty, manager of the GE Research and Development Centre's Power Electronics Laboratory. "Many existing electrics are modifications of gasoline-powered compacts or are essentially glorified golf carts," he noted.

For example, GE's test car has no grill because there is no radiator to cool. It has a low centre-of-gravity because the 1225 pounds of batteries are slung on a moveable trolley beneath the vehicle and run nearly its full length. The 24-horsepower DC series traction motor is tilted at an angle because the geometry of the drive train is simpler.

Dr Lafferty explained that one of the prime considerations of the vehicle's design was to duplicate the "feel" of a conventional car. For example, the front seating arrangement, instrument panel, and floor-mounted automatic shift lever are similar to those found in conventional cars. Dials on the instrument panel show the amount of energy stored in the battery (similar to a fuel gauge) and measure electric current in amperes. Rounding out the panel are the usual warning lights showing whether the power is on, the battery is charging, the lights are at high beam, or if there is a brake failure.

TI may plunge into photovoltaics

Energy insiders say that Texas Instruments Inc is preparing to plunge into solar cells by the year's end, getting into both manufacturing and systems use. Indications of TI's interest in solar cells include its quiet acceptance of Department of Energy R&D money totalling about $US3 million over the last two years, and an in-house proprietary systems project.

Charles E. Sporck visits Australia

National Semiconductor held a banquet at the Melbourne Hilton in October, to celebrate the 10th anniversary of its operations in Australia. Guest of Honour at the banquet was Mr Charles E. Sporck, President of National Semiconductor and the man who has guided the corporation through 11 years of phenomenal growth.

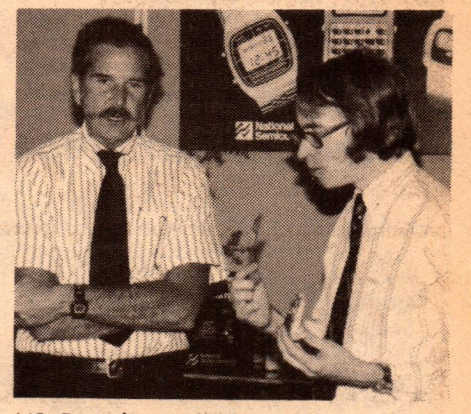
In his address at the banquet Mr Sporck spoke briefly of the difficulties experienced by National following the destruction of its Scottish wafer fabrication plant in April 1977, and the current problems of product supply. He then spoke about future trends in the semiconductor and electronics industries.

A firm believer in free enterprise and the benefits of technology for society, Mr Sporck is a tall imposing man of 49 with a flamboyant moustache and a surprisingly deep voice. He tends to dismiss talk of technology producing unemployment, arguing persuasively that the increased productivity produced by technology has always increased overall employment, and in his view will continue to do so for the foreseeable future.

Mr Sporck became President of National in 1967, when it was a fledgling in the industry with a turnover of $US8 million a year. Turnover last year was almost $US500 million, making it second largest IC manufacturer and third largest semiconductor maker in the world. Things look even better for the current year, with a first-quarter turnover of $US184 million and profit of $US8.8 million.

National has recently brought a new fabrication plant on stream at Salt Lake City, Utah, as well as the plant in Scotland which was rebuilt in a recor nine months. Both plants are runnin 100mm diameter wafers and using pro jection lithography from E-bean. generated masks. The Salt Lake City facility is devoted to MOS memory device fabrication, and current output is 25,000 wafers per month. This is expected to quadruple before the end of 1979.

Before leaving Australia Mr Sporck addressed the first conference of National Semiconductor computer users, held in Melbourne's Brighton in the two days following the banquet. He also gave an address at the 21st Food Industry Convention and Exhibition, dealing with the impact of technology on food marketing.



NS President Charles E. Sporck (left) talks with Applications Engineer Ed Schoell.

Lockheed to study solar cell production

Automated production of photovoltaic cell assemblies, aimed at sharply reducing the cost of generating electricity directly from the Sun, is being studied at Lockheed under a one-year US Department of Energy contract.

The goal of the Low-cost Solar Array Project (LSA) is to produce electricity at 50 cents (US) a peak watt in less than 10 years to supplement the nation's power supply. Present costs are more than $US11 a peak watt.

A peak watt is the amount of electrical power that can be generated when solar cells are exposed to bright sunshine on a summer day.

Silicon solar arrays have been used for years to reliably power spacecraft, but their application to terrestrial needs has been limited by high production costs.

Under the contract, Lockheed will review today's production technology to determine what should be retained and will investigate possible new techniques that would help to achieve the goal of lower cost, according to Project Leader Mike Lopez of Lockheed Manufacturing Research organisation.

The contract will also include experiments with ion implantation of selected impurities to form juctions (enabling the cell to generate electricity when exposed to direct sunlight) and laser annealing.

Watch the money go

The recently developed Monitel telephone charge clock shows the cost of a telephone call as it accumulates. This, the British manufacturers claim, will discourage lengthy calls and prevent mounting telephone bills.

Designed to sit under the telephone set the Monitel functions completely automatically. It is programmed to adjust itself to peak, standard and cheap rate periods and to overseas charge rates. The cost of the call it displays includes any current subscriber tax. These instructions are provided by a punched card which is inserted into the Monitel in a simple once-and-for-all operation. When rates change a new card is automatically supplied for a nominal fee.

When not in use the display doubles as an accurate electronic digital clock:

The unit (not yet available in Australia) is manufactured by Monitel Ltd, Berechurch Rd, Colchester, England.

Just a second!

The Bureau International de l'Heure has announced that a positive leap second will be inserted in the scale of Co-ordinated Universal Time (UTC) at the end of December 1978. This means that the last minute of 31st December 1978 UTC will be 61 seconds long; the second-last second (the sixtieth) of this minute will commence at 23h 59m 59s and finish at 23h 59m 60s UTC on 31st December 1978, and the last second (the leap second) will commence at 23h 59m 60s and finish at 0h 0m 0s UTC on 1st January 1979. This last mentioed instant corresponds to 11h 0m 0s Australian Eastern Summer Time.

Time signals emitted by the Australian Telecommunications Commission's Standard Frequency and Time Signal Service VNG, Lyndhurst, Victoria, will be adjusted in accordance with the change. Speaking clock services and hourly time signals will also be adjusted such that the signal which marks 11h 0m 0s Australian Eastern Summer Time on 1st January 1979 (and the corresponding times in other States) will occur at 0h 0m 0s UTC.

NEWS HIGHLIGHTS

2MBS-FM: 4 years of progress

A companion photograph to the one featured on our front cover, the above picture shows volunteer announcer Glen Bulgin on duty in studio B at radio station 2MBS-FM in Sydney. The station has two presentation studios in full operation around the clock, and is working towards a third, "live" studio as labour and funds permit.

2MBS-FM is operated by the Music Broadcasting Society of NSW Coop. Ltd, transmitting mainly classical music in full stereo, but with a sprinkling of other cultural programs and other special interest contemporary music not commonly broadcast by national or commercial stations.

Transmission began in 1974 with a temporary licence issued under the "Wireless Telegraphy" Act, but 2MBS now operates as a community station with an "S" licence authorised by the Australian Broadcasting Tribunal. The frequency is 102.5MHz and the ERP (effective radiated power) is 3kW from a horizontally polarised antenna. The statio plans to increase power and use crossed polarisation as soon as practical.

As a community station, 2MBS-FM is heavily dependant on donations of money and equipment, and on voluntary effort covering all aspects of the operation, through to actual program presentation. Vital to its existence are membership subscriptions, which cost $25 per year, and which entitle the member to a copy of the monthly journal "Stereo/AM Radio". (The membership fee for students and pensioners is $15 per year).

Webster wins education contract

The Victorian Education Department has purchased 10 educational computing systems from D. D. Webster Electronics Pty Ltd, an Australian mini computer manufacturer based at Scoresby, east of Melbourne. The systems, each costing around $10,000, will use Webster's Computex Spectrum 11B/32KB (dual drive) computer as the basic hardware.

The managing director and founder of the company, Mr David Webster, said that this was the largest bulk purchase of his computer by an Australian government department. He regards it as significant recognition that his Australian-made Spectrum now has equal competitive status with overseas minis in the eyes of local purchasing authorities.

The Webster ECS which runs the Monash Educational Computer Software (MONECS) has been purchased by the TAFE (Technical and Further Education) division of the Department. In addition to the Spectrum and software it will include a DEC LA 180 Line Printer and PDI 2022 HMT Card Reader.

Automatic signature verification system

Field trials of a new signature verification system developed at IBM's Thomas J. Watson Research Centre showed that the system has excellent reliability. Of 2958 valid signatures obtained from 248 individuals, 2907 or 98.3% were accepted, while the system rejected no less than 490 forgeries out of a total of 492 — 99.6%. It is believed that these results are the best ever achieved by an automatic signature verification system to date.

Developed by an IBM team led by Dr Noel M. Herbst, the system does not read the handwriting as such. Rather a series of accelerometers and a pressure detector built into the barrel of a pen, linked to a computer, detects the pattern of accelerations, pressure variations and hesitations which are characteristic of each person's signature. The system uses two reference signatures, and notes their similarities while ignoring the gross changes that often occur.

The system is based on the results of IBM studies which showed that when familiar patterns such as one's signature are written rapidly, the timings of muscular movements become habitual and beyond deliberate control.

PICTURE-IN-PICTURE TV RECEIVER

This new Grundig 8281 colour TV enables a viewer to watch two programs at the same time — the normal program in colour, plus a program in b & w on the same screen. The alternative program is selected only as required, and is about the size of a postcard. Suggested retail price is $1,620.

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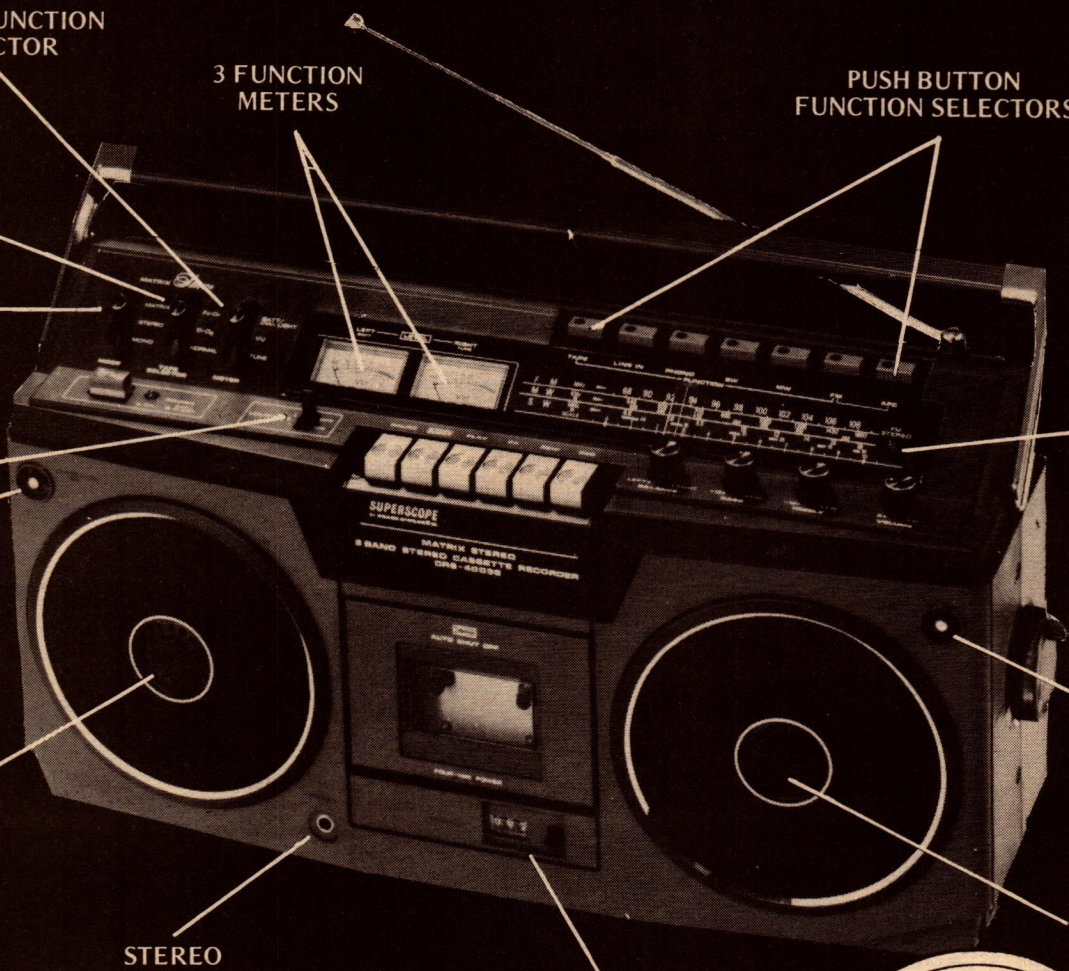

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NEWS HIGHLIGHTS

New type of solar furnace

An Australian inventor has developed a new type of solar furnace which does away with most of the moving parts used in conventional solar power tower designs. The device is designed to produce electricity with an overall efficiency of around 50%.

Conventional solar towers make use of steerable mirror arrays, called heliostats, to direct and focus the Sun's rays onto a boiler to produce steam. The steam is then used to drive a turbine to produce electricity. A typical STA installation nearing completion in the United States employs an array of 222 heliostats, and a lot of moving parts are needed to steer these so that they track the Sun.

The Australian invention does away with all these parts by employing a fixed concave reflecting surface in place of the heliostats. Essentially, the reflecting surface forms the bottom half of a hollow sphere which is open at the top, and through which passes a north-sound fluid conveying pipe. Inside the sphere, the pipe is bent in the shape of a semi-circle and is arranged so that it can revolve about its horizontal axis.

The pipe is also arranged so that, as it is rotated, the curved portion can always be made to intersect the focal point of the reflector. This focal point will change position (due to spherical aberration) according to the position of the Sun. The new furnace is thus able to track the Sun simply by moving the curved portion of the pipe from west to east during the day.

Steam produced in the pipe at the focal point can be used to drive a turbine to generate electricity, as with a conventional system. Main advantages of the new system are said to be considerably simplified tracking equipment and reduced cost.

Reader enquiries should be directed to Mr S. W. Birkle, 208 Albany St, Gosford, NSW 2250.

Solar design software

A set of programs to allow solar panel and collector designers to develop more effective designs using a Hewlett-Packard HP-97 programmable printing calculator has been produced by Sunshine Power Company, a firm based in San Jose, California. The programs are printed on HP-97 magnetic programming cards and are designed to replace inexact tables or expensive computer time.

The software package has programs for providing a solar radiation data table, fixed surface radiation data, fixed surface hourly calculations for a selected month, flat-plate collector performance, and sun position data table. Two other programs are available, one for normal surface radiation and the other normal surface data.

All programs may be ordered from Sunshine Power Company, 1018 Lancer Drive, San Jose, California 95129.

Single-gun colour TV

Matsushita Electric has developed a new low-power colour TV receiver which uses only a single electron gun and no shadow-mask in the cathode ray tube. The 12.5cm diagonal tube still has stripes of the three colour phosphors, but the colour information is multiplexed onto the single electron beam using feedback from additional ultraviolet-emitting stripes to ensure synchronisation. The single electron beam is used for around 60% of the time, compared with about 20% for conventional tubes.

Power drain of the new receiver is only 7W compared with 12W for a comparable earlier model, even though the deflection angle has been increased from 50 to 70 degrees.

Microwaves may trigger fusion power plants

Researchers at the Massachusetts Institute of Technology are planning to use microwave energy in an attempt to achieve nuclear fusion in a Tokamak plasma. By beaming 4 megawatts of peak power at a frequency of around 4GHz into the plasma, they hope to produce the 100,000,000°C temperatures necessary to produce a sustained fusion reaction.

The microwave power will come from 16 klystron tubes, each with a peak output of 250 kilowatts. The klystrons will be fed into the Tokamak fusion chamber via the diagnostic ports. As the ring of plasma in the chamber is opaque to microwave energy, the energy is absorbed and the plasma temperature increased significantly.

The klystrons are due to be installed at MIT around June next year, and the complete system operational by August 1980. But according to the group leader of the project, Ronald Parker, it may be 1985 before repeatable fusion conditions are attained.

A group of researchers at Princeton University recently achieved a temperature of 60,000,000°C in a hydrogen plasma by introducing a neutral beam of deuterium. This is the highest temperature attained in fusion experiments to date.

Business Briefs . . .

● Plessey Avionics and Communications in the UK has developed what is claimed to be a new concept in radio technology, which will have a major impact in battlefield VHF communications. Dubbed "Groundsat", it is a portable unmanned repeater station which retransmits signals on the same frequency as they are received. This allow communications to take place on a single common channel.

The Groundsat station is described as no larger than a man-pack radio, and easily deployed by one man. In operation it is totally unmanned. Plessey anticipates orders for the new equipment from several overseas armies.

● Zephyr Products has been appointed by Photo Scan Pty Ltd as sole Victorian distributor for the Javelin range of closed-circuit TV equipment, the highly specialised range of Javelin night viewing devices, the Schirmer range of surveillance camera systems and the state-of-the-art Video Tek digital intrusion detection analyser. Enquiries to Zephyr Products at 70 Batesford Road, Chadstone, Victoria 3148.

● Electronic Agencies, of 115-117 Parramatta Road, Concord, NSW has recently been taken over by Bill Edge. Bill advises that the store will be handling a wide range of electronic components and hardware, including a range of kits for EA projects. Bill Edge himself will be running the store, drawing upon his 16 years experience in the industry. Before acquiring Electronic Agencies he was manager of the Dick Smith Electronics store in Parramatta.

● Beyschlag Apparatebau GmbH has appointed Slide-N-Dial Pty Ltd as its exclusive Australian agent, effective from January 1st, 1979. Beyschlag is Europe's largest manufacturer of carbon film and metal film resistors, and has gained a world'wide reputation for these products. For further information contact Slide-N-Dial Pty Ltd, 81 Princes Highway, St Peters 2044.

Dwindling supplies of fossil fuels will force the inevitable transition from non-renewable to renewable sources of energy within the next few decades. Indeed, one renewable energy source — solar power — may become economically competitive with fossil fuel power stations by the 1990s.

Energy: the solar alternative

by DR R. J. BRAY and DR R. E. LOUGHHEAD

CSIRO Solar Observatory, Culgoora, NSW 2390.

Our modern industrial society owes its existence to the availability of large reserves of low-cost fossil fuels. These have been stored up over past aeons in the form mainly of oil, coal, and natural gas. Since the start of the Industrial Revolution mankind has been profligate in the use of these resources and continues to consume them at an increasing rate.

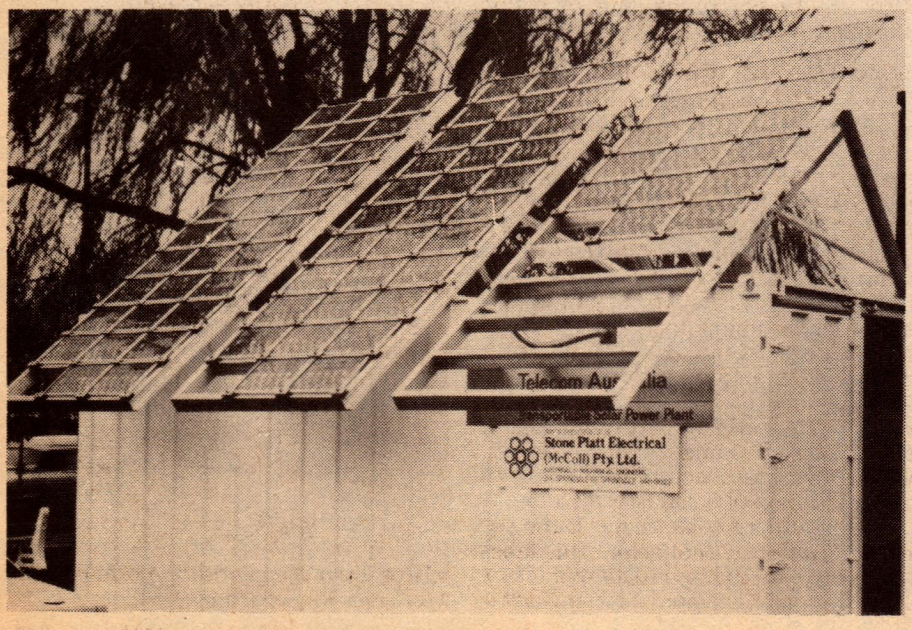
Serious shortages of oil are expected by the 1990s. Natural gas and easily-won coal will also become scarce over the next few decades until, finally, we shall be faced with the prospect of becoming totally dependent on *renewable* as opposed to the present *non-renewable* energy resources.

The fashionable term "energy crisis" is an exaggeration since there are almost unlimited renewable resources which are promising candidates for future exploitation. For example, in theory Australia's total energy consumption could be met by a solar power plant collecting solar radiation from an area of about 4000 square kilometres and operating at 10 per cent efficiency. This area is only 0.05 per cent of Australia's land mass.

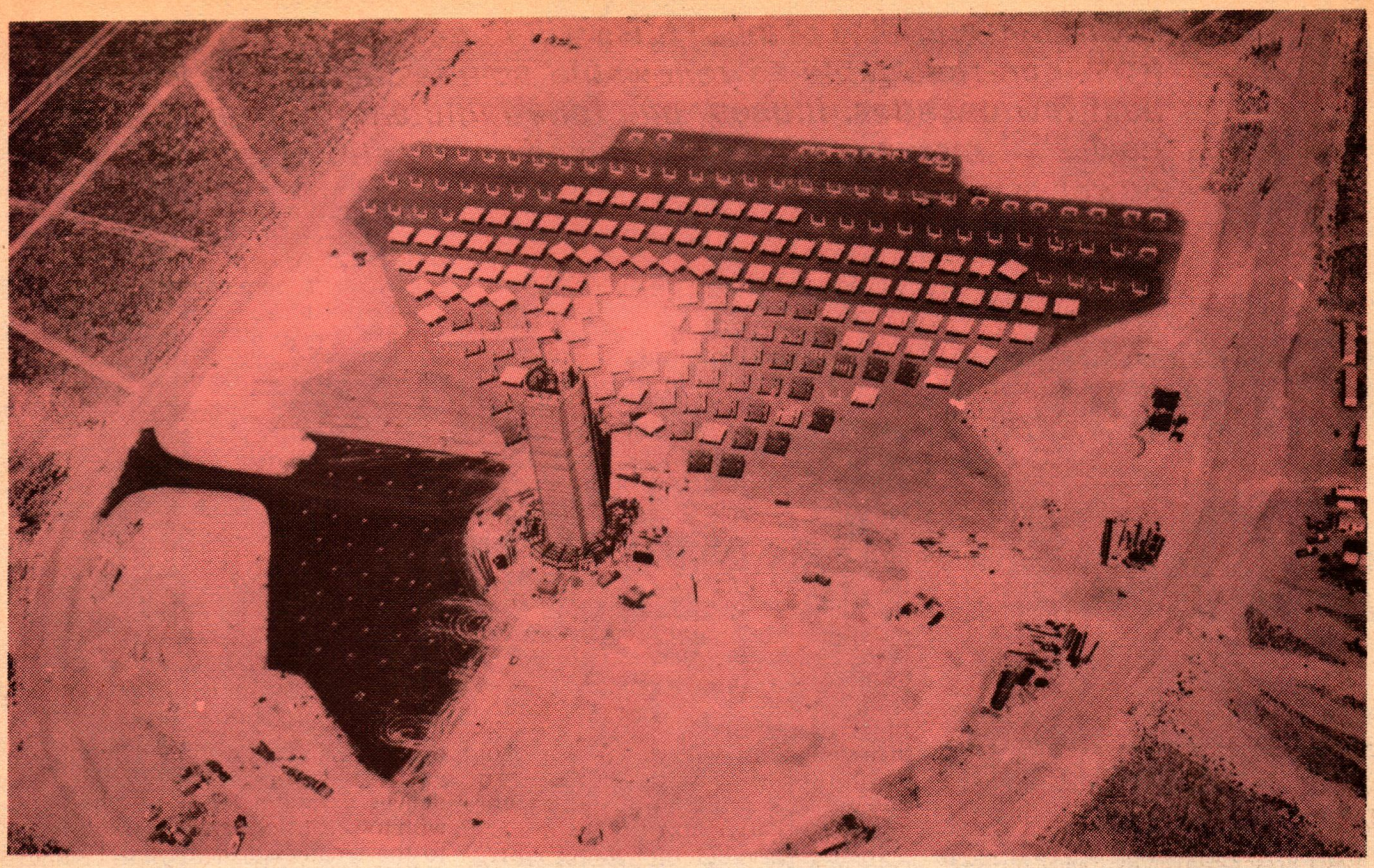
Nevertheless, the inevitable transition from non-renewable to renewable energy resources is going to pose financial, technological, and sociological problems. The renewable energy is certainly there, but it has to be collected economically, transformed into the various forms we require, and delivered to the locations where we wish to use it. Society will have to adapt to the changes brought about by this transition. Some of the changes, for example increased decentralisation, may be welcomed as contributing to a better quality of life.

Besides solar energy itself, there are other renewable sources which owe their origin indirectly to the Sun. These include power from the winds, the waves and the tides, and from ocean thermal gradients. All of these have promising features and are being actively studied at a number of laboratories throughout the world. However, in this article we shall confine ourselves to the direct use of solar energy. Moreover, we shall exclude the "bioenergetic" approach, which has already been the subject of a recent article (see "Suggestions for Further Reading").

The development and widespread introduction of any major new technology is always a lengthy process. For example, in the case of nuclear power, it took some 30 years to advance from the first experimental reactors to power reactors making a significant contribution to electric power generation, and then only in a handful of advanced countries. Even now nuclear power technology is incomplete since a safe method for disposing of radioac-



Array of photovoltaic cell panels with a peak output of 800-850 watts. Transportable plants of this type are being used to power a chain of 13 microwave repeater stations in central Australia. (Photo courtesy Telecom Australia).



Aerial view of solar power tower test facility under construction near Albuquerque, New Mexico, USA. The heliostat array directs solar energy to boiler in tower. (Photo courtesy Sandia Laboratories, US Department of Energy).

tive waste has yet to be demonstrated on a commercial scale.

Similar lengthy lead times can be expected for solar technology and for any other renewable energy sources that we may decide to exploit. Moreover, the introduction of such technology on a sufficiently large scale will require not just time and money, but also *energy:* the new power systems that we shall need must be built while large amounts of fossil fuel or uranium are still available at reasonable prices.

How much time do we have? Nobody really knows. In Australia the known oil reserves are very limited but we have comparatively large reserves of coal, natural gas, and uranium. However, the time available depends not only on our own (increasing) rate of consumption but also on the growing demands on our energy resources being made by other countries.

The more enthusiastically we export our coal and uranium to Japan, the USA and the European countries, the less time we shall have available for the introduction of solar and other forms of renewable energy. It has been suggested that we should go slow on such exports until the Federal and State Governments have agreed upon a national energy policy. An integral part of such a policy should be a timetable for a smooth transition in Australia from non-renewable to renewable sources of energy.

Many observers of the energy scene think that it would be prudent to take positive steps now to start introducing selected renewable energy options. The aim of this article is to provide the reader with a background which may help him or her develop an informed opinion about just one of these options, namely the direct use of solar energy. In a short article it is not possible to cover all actual and potential applications and we shall limit ourselves to describing four of major importance.

Solar Heat for the Home

The supply of domestic hot water is one area in which solar energy has already started to make a significant impact. However, it is still usually necessary to fall back on conventional power during periods of prolonged cloud. The economic attractiveness of solar heating for the individual householder can be strongly influenced by government incentives and by the price charged for the back-up power by the local supply authority. There is a growing market for solar water heaters in Australia, Israel, Japan, the USA and some other countries, where their manufacture is the basis of an expanding new industry.

The heart of a solar heater is the so-called "flat plate" collector. This takes the form of a shallow rectangular box with thermally insulated back and sides, whose front is covered by a sheet of glass. The Sun's rays pass through the glass onto a blackened metal panel at the back. This becomes hot and heats water circulating through pipes embedded in the panel or bonded to its back surface.

As in a greenhouse, the glass plate absorbs far infra-red radiation emitted from the heated surface and thereby reduces energy loss. With such a device, a stored water temperature of up to 60°C is easily achieved.

25 watt solar concentrator module from Motorola Inc, Arizona, USA.

Energy: the solar alternative

Solar Heat for Industry

Industry has a great demand for hot water and steam in the temperature range 60-150°C for processing such basic items as food and minerals. Improved versions of the simple flat plate collector described above are now available which can deliver hot water at temperatures up to 95°C. This has been done by reducing the energy loss from the heat absorbing panel due to conduction, convection, and radiation.

Some of the methods which can be used to do this are as follows:

1. placing a second sheet of glass a short distance above the first one, thereby reinforcing the greenhouse effect and reducing the energy loss due to convection in the air just outside the glass;
2. removal of the air inside the box to stop internal convection;
3. coating the glass with a "selective" film which transmits the visible and near infra-red light coming from the Sun but reflects back the far infra-red heat radiated by the absorber;
4. coating the absorber with a selective layer which absorbs strongly in the visible and near infra-red but emits poorly in the far infra-red; and
5. concentrating the sunlight onto the absorber by means of reflecting surfaces. One type of commercial unit takes the form of an evacuated cylindrical glass tube whose lower half is silvered on the inside to concentrate sunlight onto two blackened water pipes running parallel to the tube's axis.

Solar collectors with such improvements cost more than the simple types usually used for domestic water heating and their introduction into industry is still largely at an experimental stage. Meanwhile, research continues around the world into the design of better but cheaper solar heaters, including units capable of generating steam.

In Australia, active work on improved solar heaters for industry is being undertaken by a number of institutions, including the CSIRO, the Universities of Sydney, Melbourne, and New South Wales, and the New South Wales Institute of Technology.

Solar Electricity: The Photovoltaic Cell

The photovoltaic cell in its modern form is one of the most valuable by-products of the space program. Solar cells nowadays provide the power for most space satellites, once in orbit. Similarly, on Earth they are ideal for applications where their present rather high cost is outweighed by their simplicity and convenience.

One important application has been pioneered by Telecom Australia, which plans to use solar cells to power a chain of 13 microwave repeater stations spanning the 580km distance between Tennant Creek and Alice Springs. At each station an array of solar cell panels will produce about 800-850 watts peak. Telecom engineers expect the cells to last more than 10 years.

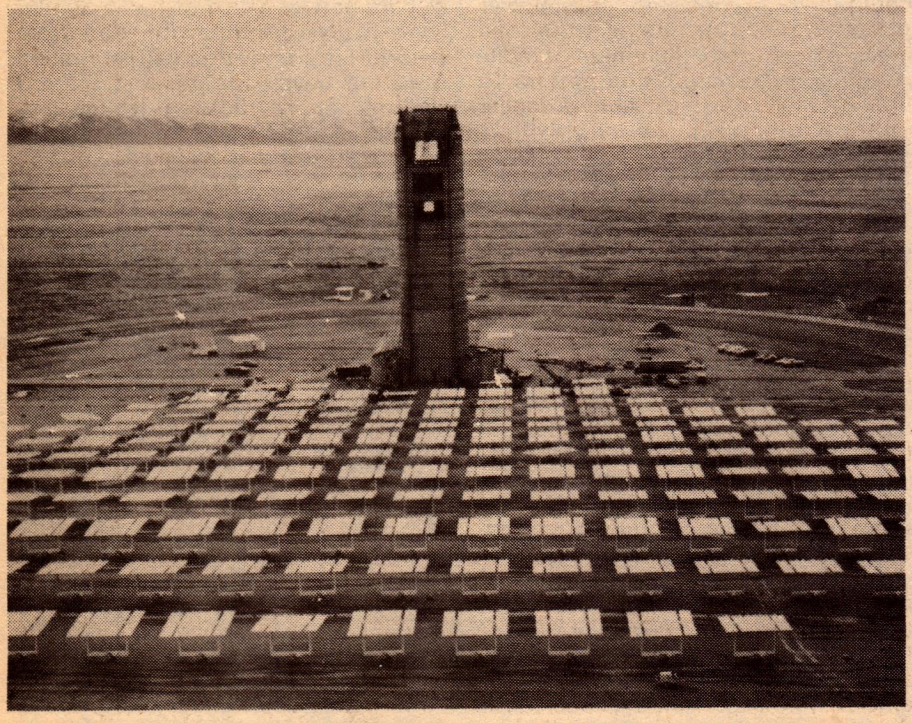
A solar cell consists of a thin wafer of very pure crystalline silicon to which controlled amounts of impurities have been added. The body of the wafer is usually doped with boron; the top of the wafer is doped with arsenic, antimony, or phosphorous, which is diffused a short distance down into the wafer. The presence of these impurities causes each side of the crystal to become a "semiconductor" containing positive and negative charges. Electric leads are attached to the top and bottom surfaces of the cell. When the top is illuminated by sunlight, a voltage is developed across the cell.

A commercially available cell made by Philips, for example, is 60mm in diameter and 0.3mm thick, and generates about 0.5 volts. To produce any required combination of voltage and current, solar cells can be connected up in series and parallel, as in the case of conventional batteries. A solar panel of 34 cells sold by Philips gives 0.7 amps at 15.5 volts in full sunlight and costs about $300.

A disadvantage of present-day solar cells is their rather low efficiency. The theoretical efficiency of a cell of the silicon type is about 24 per cent, but the actual efficiency now being achieved by commercial cells is about 13 per cent. Thus only one-eighth of the solar energy falling on a cell (1 kilowatt per square metre in bright sunlight) is actually converted into electricity. One reason for this is that the cell is not sensitive to solar radiation outside a certain range of wavelengths.

A more serious disadvantage is that they are costly to make. However, the US Department of Energy is financing a big program of purchase, research, and development with the twin aims of reducing the cost and enlarging the country's industrial capacity to produce solar cells. (This is one aspect of the far-sighted renewable energy program being sponsored by the US Government.) In 1976 the Department of Energy purchased cells with a total capacity of 130 kilowatts at a price of $US15,000 per kilowatt, but hopes by 1986 to reduce the cost to $US500 per kilowatt. Other experts consider $US2000 per kilowatt a more realistic goal for the next decade.

Present applications of solar cells include communications and space research satellites, microwave repeater stations, light beacons and buoys for sea navigation, and radio beacons for air navigation. In all these cases, their high initial cost is outweighed by convenience in powering remote or inaccessible equipment. If the large cost reduction mentioned above is actually achieved, then the future could see a big increase in the range of applications.



Close-up of portion of heliostat array and tower for housing "receiver" (boiler). (Photo courtesy Sandia Laboratories).

Solar Electricity: The Power Tower

Unlike other methods of utilizing solar energy, the power tower offers the prospect of collecting very large amounts of energy without going beyond essentially well known and well tried technology. This new method is now undergoing vigorous development overseas, particularly in the USA.

The US Government and the Southern California Edison Company are jointly planning to build a solar power plant at Barstow in California's Mojave Desert. This plant will be capable of feeding the electricity grid with commercially significant amounts of electricity. The electrical capacity will be 10 megawatts (10,000 kilowatts) and the plant is due for completion in 1981.

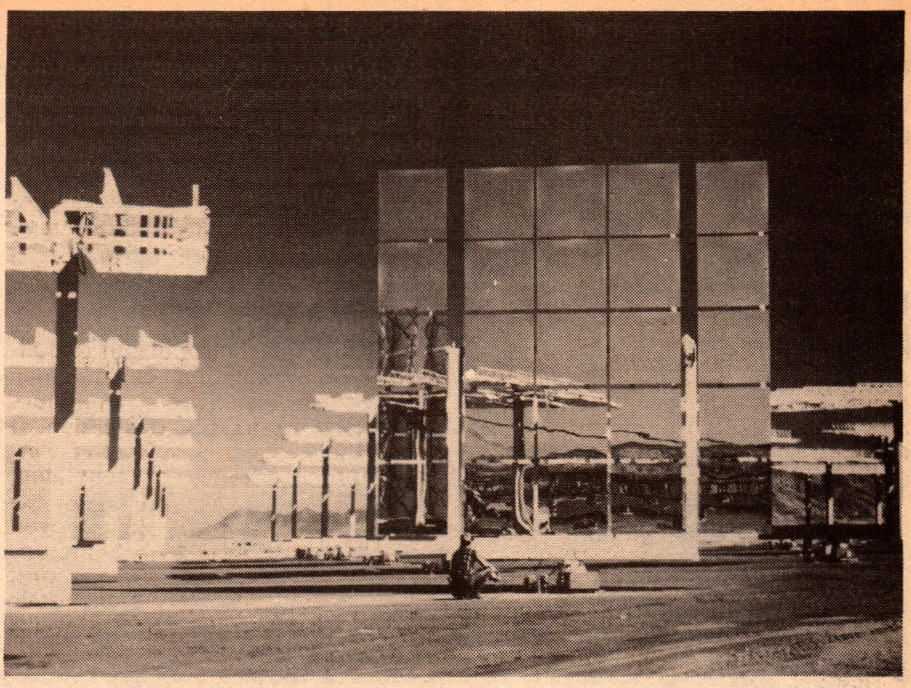
A forerunner of the full-scale plant at Barstow is a power tower test facility now nearing completion near Albuquerque, New Mexico. This has a "receiver" carried on a tower 61 metres high and fed sunlight by an array of (initially) 222 "heliostats". A heliostat is simply a mirror which is slowly rotated by means of motors about two axes in such a way that it reflects a beam of sunlight in a fixed direction despite the Sun's daily movement across the sky from east to west. Each heliostat is independently guided by computer control.

Guiding the heliostats is quite simple. Solar physicists have had long experience in guiding their telescopes with much greater accuracy than that needed for a power tower. Nevertheless, the heliostat array is the most expensive part of the plant.

In the Albuquerque installation each of the 222 heliostats contains 25 mirror facets, each facet being 1.2 metres square. A lot of glass is needed but it does not have to be of very high optical quality. (The mirrors for the Barstow power station will have a total area of between 6.5 and 11 hectares, depending on the final design.) Like ordinary household mirrors, the heliostat mirrors have reflective coatings on their back surfaces. The frame on which each facet is mounted has a simple mechanism for slightly bending the mirror, thus producing a crudely focused image of the Sun on the receiver.

Together, the 222 heliostats will concentrate about 5 megawatts of solar energy into an area about 2 metres in diameter on the receiver. This is a specialized type of boiler, designed to withstand sudden thermal stresses caused, for example, by passing clouds cutting off the energy. The concentrated solar energy falling on the boiler produces steam at a temperature of 500-600°C, which can be used to drive a high pressure turbo-generator similar to those used in coal-fired power stations.

Because the Sun does not shine all the time, a solar power tower — particularly one designed as a stand-alone plant — needs some form of energy storage (the same need arises in the case of a photovoltaic plant).



One of the 222 heliostats. Each contains 25 mirror facets (1.2 metres square), and slowly rotates about two axes to direct sunlight to the top of the receiver tower. (Photo courtesy Sandia Laboratories).

Energy can be stored in a number of ways, such as electrical (batteries), thermal, or by production of hydrogen by electrolysis or direct chemical conversion of water. This last possibility is important because hydrogen, which is non-polluting, may conceivably be the fuel of the future for domestic, industrial, and transportation needs. One could even imagine huge solar power plants located in otherwise unused areas of our large continent steadily producing hydrogen for export to energy-poor countries such as Japan. This could provide Australia with a large permanent export income without using up our coal, uranium, natural gas, or any other resource.

The power tower has certain disadvantages: it uses only direct radiation from the Sun, not the diffuse, scattered radiation from the rest of the sky. Thus it will only operate properly in bright sunlight whereas a solar water heater or a photovoltaic array, for example, will work quite well on a hazy day or even in conditions of light cloud. It has some undesirable environmental impact since it is large and unattractive. However, any thermal effect on the environment can be reduced to a very small amount.

On the credit side, the power tower uses known technology and conventional and readily available materials (glass, steel, concrete). It operates with a relatively high overall efficiency (an efficiency of 20 per cent is expected for the Barstow plant), is non-polluting, and can make use of an existing electrical distribution network. Thus every user of electricity could share in the "free" energy from the Sun — not just those home and factory owners able to afford the high capital outlays required for individual solar heating or cooling systems. Moreover, the consumer avoids the inconvenience and cost of maintaining his own solar system.

Geographically, Australia would seem well placed to exploit solar energy for the direct generation of electric power. Much of the continent is virtually desert, with abundant sunshine and relatively clear skies. Averaged over the year, the total amount of solar radiation falling each day on certain parts of central and northwest Australia exceeds 6 kilowatt hours per square metre. This is comparable with the amount received by the arid regions in the favoured southwest corner of the USA and is more than twice the figure for northern Europe. Australia has an advantage over the USA in that the incident solar energy is more uniformly distributed: the daily average over all parts of Australia, except for the southwest and southeast corners and Tasmania, lies between 5 and 6 kilowatt hours per square metre.

Besides the American developments already described, at least six other countries and two multinational organizations (the International Energy Agency and the European Economic Community) are making serious plans to design, construct, and test solar electric power systems.

In France, a 0.8 megawatt plant is planned and one of 3.5 megawatts is under consideration. In Italy, a 1

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Microwave Equipment and Systems

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Printed Circuit Technology

Computer Aided Design

Colour Video Display Systems (VDU Technology, B/W and Colour.)

Television Studio Production Techniques
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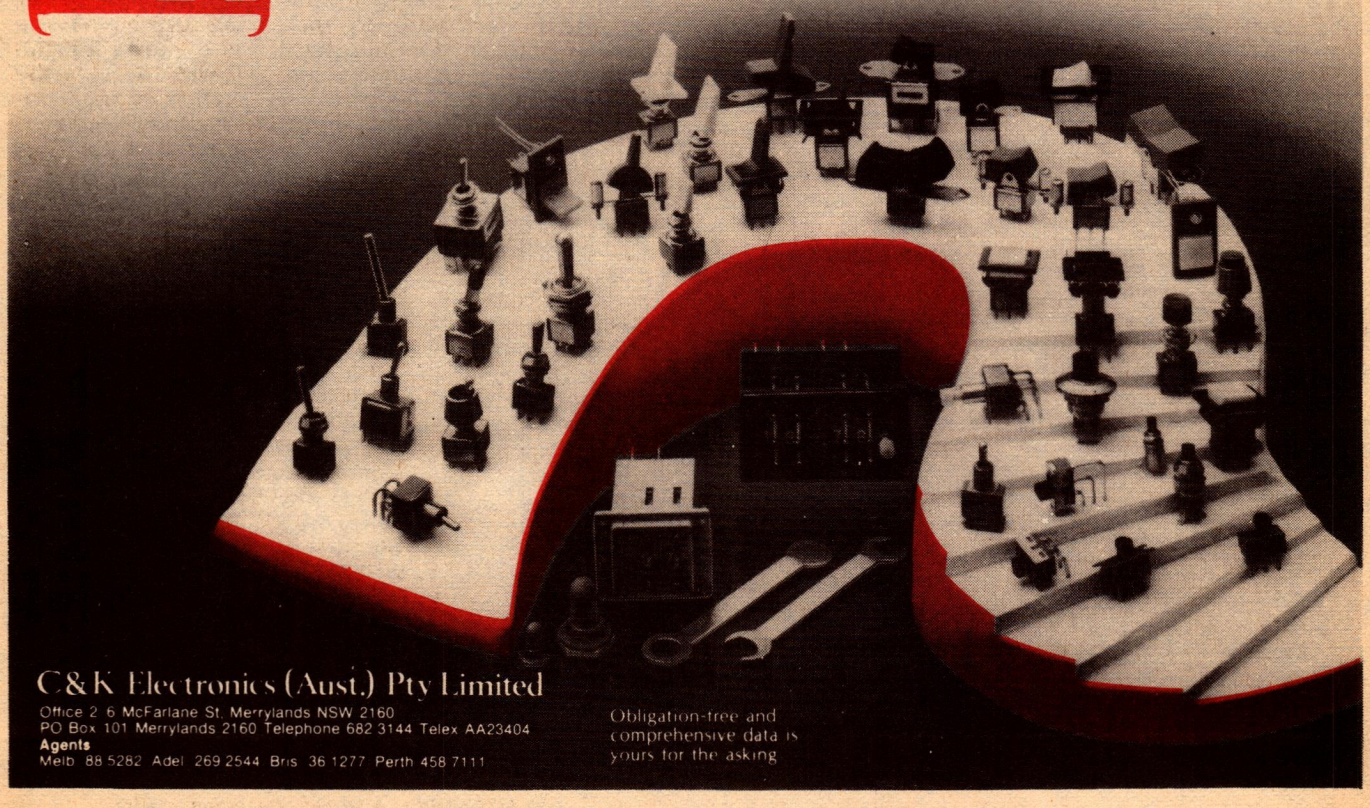

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megawatt advanced experimental system is to be built jointly with other countries under EEC sponsorship. In Japan, Mitsubishi and Hitachi are preparing designs for a 1 megawatt plant to go into operation in 1980. The IEA is sponsoring a co-operative effort to study and build small (0.5 megawatt) solar power systems both of the central tower and distributed receiver types. The countries involved are Germany, Austria, Belgium, Greece, Italy, Spain, Sweden, Switzerland, the United Kingdom, and the USA.

Overseas countries have realized that a large measure of international co-operation will be required to achieve a smooth transition from non-renewable to renewable energy sources. What role will Australia, as a wealthy country with large areas of unused land, play in this international endeavour?

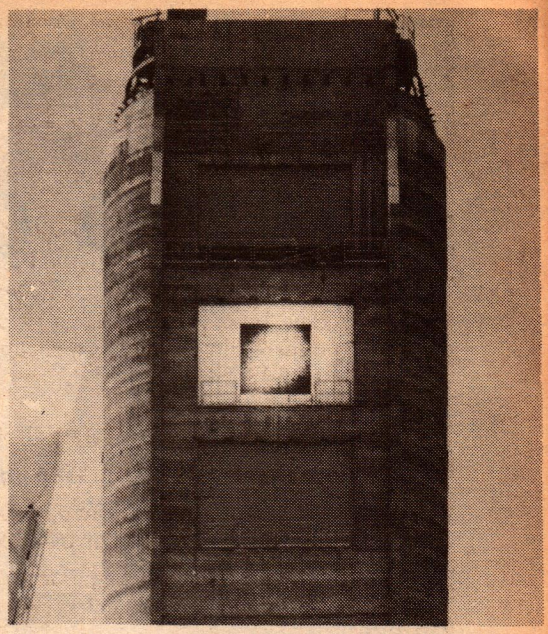
One step in this direction has been taken by the newly-formed Solar Energy Research Institute of Western Australia. In conjunction with the State Energy Commission, it has approached a number of overseas countries to seek collaboration in constructing a small solar power station (not of the central tower type) at a remote site in the north of the state. Western Australia has very limited reserves of coal for electricity generation compared to the eastern states and, in the words of the State's Minister for Fuel and Energy, "... would be an ideal testing ground for solar power generation".

The Cost to the Community

Although sunlight itself is free, the cost of collecting it and converting it to a form suitable for use on a large scale will be considerable. The same will be true of other renewable energy alternatives. How are we going to pay for the inevitable transition from non-renewable to renewable energy sources without undue disruption of the economy? Already, for example, the USA is spending some $US400,000,000 per year on solar energy development.

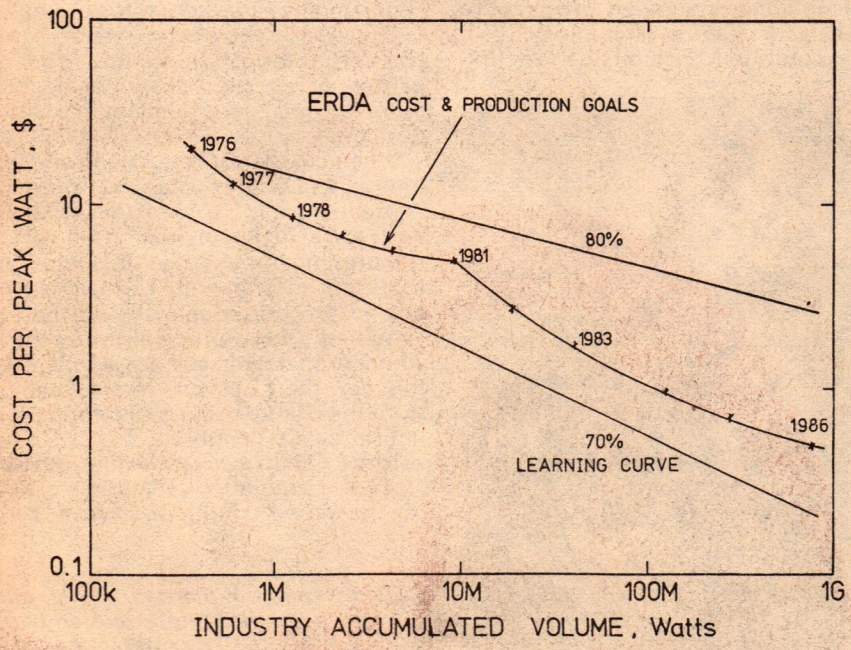
At present, Australia is consuming or exporting its inheritance of non-renewable resources — oil, coal, natural gas and, shortly, uranium. However, governments have already realized the necessity of increasing the price of dwindling energy sources beyond the normal costs of production and marketing. This by itself will hasten the development of alternative energy sources by making a comparison of the cost of existing and new systems more realistic.

There are growing indications that the large-scale introduction of solar energy may become economically competitive with nuclear and other conventional alternatives by the 1990s. In a recent report the US Council on Environmental Quality, a government agency, concluded that "... the view of solar energy as a rather exotic energy source of little practical significance from the standpoint of our large energy requirements is no longer justified ..." The Council further believes that with accelerated development and a serious effort to conserve energy "... solar technology could meet a quarter of our energy needs by the year 2000 .... It is now possible to speak realistically of the United States becoming a solar society ...."



Receiving bays at top of tower where experimental solar boilers will be tested. Sunlight from some of the heliostats is seen here striking the central bay. (Photo courtesy Sandia Laboratories).

Should Australia follow the solar path? Or should we pursue some other route to energy self-sufficiency? The decision lies in the hands of the Australian people who, it is to be hoped, will be kept adequately informed about the complex issues involved and the options available.



Solar cell cost and production goals of the US Energy Research and Development Administration (ERDA). Shown is the manner in which the cost of solar cell arrays is expected to decrease as the volume produced increases. The goal: to produce arrays costing $US500 per peak kilowatt by 1986.

Suggestions for Further Reading

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(2) *Potential Energy — An Analysis of World Energy Technology.* M. Kenward. Cambridge University Press (1976).

(3) *Non-Technical Issues in Solar Energy Development.* A. S. Miller. "Search", April 1978.

(4) *Solar Water Heating.* "Choice" (Journal of the Australian Consumers' Association), July 1978.

(5) *Energy: The Bioenergetic Alternative.* C. C. Curtain, CSIRO Information Serive Leaflet, June 1978.

(6) *CSIRO and Solar Energy.* CSIRO Information Service Leaflet, January 1976.

(7) *Solar Energy: Progress and Promise.* Council on Environmental Quality, Executive Office of the President. US Government Printing Office, April 1978.

Bright future for charge coupled devices

Since its invention in 1969, the charge-coupled device (CCD) has progressed from exploratory development to practical use as a revolutionary optical sensor, a powerful electronic memory, and an efficient signal processing device. Its development will make possible new and improved systems for voice, video and data communications.

In 1969, while exploring new ways of handling information storage in semiconductor devices, Bell Labs scientists Willard S. Boyle and George E. Smith invented the remarkably versatile Charge-Coupled Device, or CCD. Embodying an entirely new principle called charge-coupling — the precise control of packets of electrical charge in a slice of silicon — the CCD sparked immediate interest throughout the electronics industry.

Because the CCD promised efficient application in such varied functions as imaging, memory, and signal processing, its invention has been acclaimed as one of the most noteworthy advances in solid-state electronics since the transistor itself. But unlike the transistor effect, which scientists sought for years before its discovery at Bell Labs in 1947, the idea for the CCD came almost spontaneously to Boyle and Smith, who were searching for a semiconductor device that could handle information in the same novel way as magnetic bubbles do.

Magnetic bubbles, invented at Bell Labs in 1966, store and transfer data in the form of tiny, bubble-like domains that can be moved about in magnetic material. By 1969, bubbles had created a good deal of excitement in the electronics community, because they showed the potential for packing large amounts of data in a very small area.

Bubbles, however, were still an entirely new technology in 1969, and development engineers faced many processing and manufacturing problems. On the other hand, semiconductor integrated circuits were a relatively mature technology, with well-established production techniques. If the bubble principle could be applied to semiconductors, Boyle and Smith reasoned, a new class of electronic devices — with both the inherent potential of bubbles and the proven economies of integrated circuits — would result.

"We started batting ideas around," Smith remembers, "and invented CCDs with a speed that totally surprised us. Yes, it was unusual — sort of like the proverbial light bulb going on."

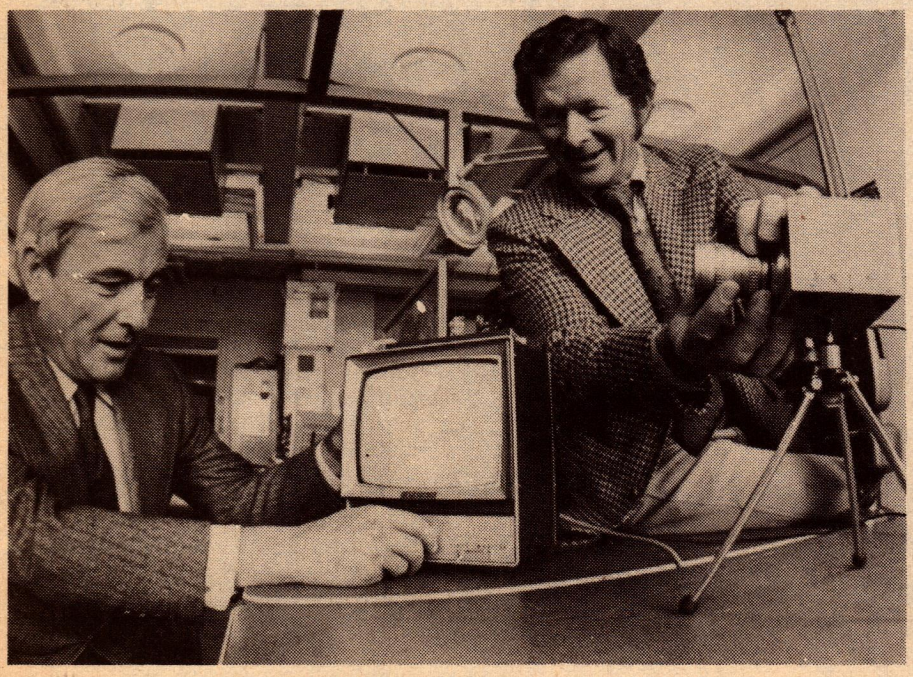
The CCD is a three-layered semiconductor device — one layer of metallic electrodes and another of silicon crystal separated by an insulating layer of silicon dioxide. They can be fabricated using standard metal-oxide semiconductor (MOS) processing techniques.

In operation, the CCD uses a phenomenon found in many of today's microelectronic devices — the ability to permit negatively charged electrons (or positively charged "holes") to move about in a controlled manner in semiconductor material. Most devices use this characteristic to change the electrical current flowing through them — to amplify or switch it, for example.

The CCD, however, stores and transfers information in the form of packets of electrical charge analogous to the tiny magnetic domains in bubble devices.

When charge packets are introduced into a CCD, they can be stored in "potential wells" at the surface. These wells are actually tiny regions in which the presence or absence of charge can represent information. The packets of charge can be sequentially moved (or "coupled") from one well to the next when proper voltages are applied. In this way, the CCD can "recirculate" or store the charge packets of information until they are needed.

The CCD is a very flexible device. Since the amount of charge in a well can be varied continuously from zero



CCD inventors Willard S. Boyle and George E. Smith demonstrate an early CCD camera. CCD cameras are now being marketed commercially by several companies, and could eventually find use in home video systems.

to some maximum amount, it is basically an analog device, and can be used as an efficient device for handling analog communications signals. When the packets of charge are digitized — ie, the wells are either empty or full — the CCD acts as a digital electronic memory.

Finally, if the charge packets are introduced optically instead of electronically — by an image focused on the light-sensitive silicon surface — the CCD can serve as an imaging device.

Looking back to 1969, Boyle and Smith recall that the entire CCD concept evolved in less than one hour of discussion. "It seemed almost too easy and straightforward," Boyle remembers. "The reactions of colleagues were varied, ranging from "I should have thought of that!" to lengthy reasons why it would not work. Within a few weeks, however, the CCD concept was proven when the first experimental devices were fabricated."

Important new device concepts often require years of effort to be transformed into cost-effective engineering applications. In this respect, the CCD was no exception. But, after several years of work by Bell Labs and other companies, CCDs have begun to fulfill their promise.

From the beginning, the most widely heralded application of the CCD has been its use as an image sensor — in effect, the heart of a solid-state TV camera. Here's how it works.

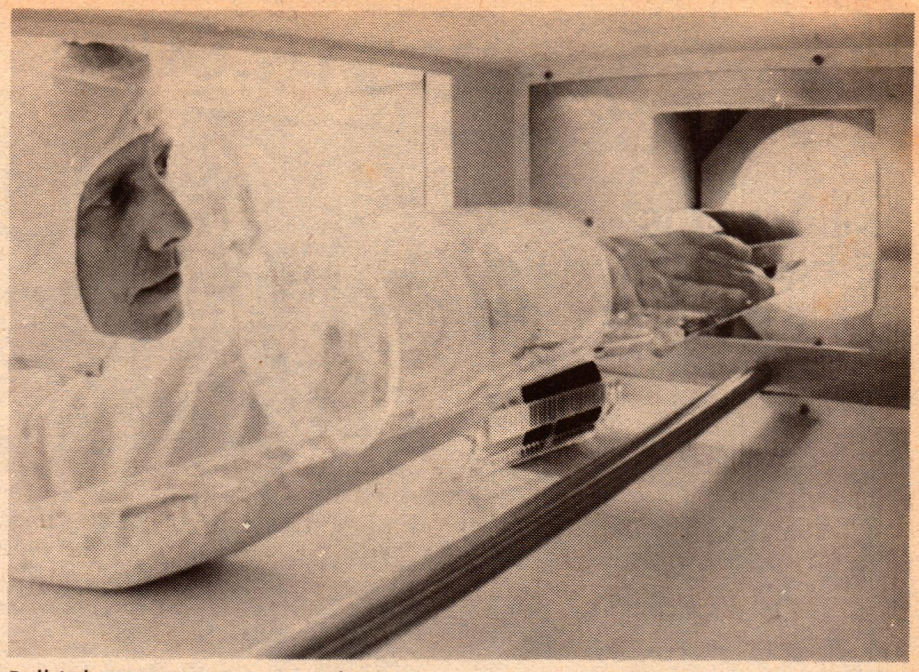
When light from an image or scene is focused on the CCD, a pattern of electrical charges is created. The charges vary in proportion to the amount of light, and serve as an accurate electrical representation of picture elements. These charges can be stored, transmitted out of the CCD chip sequentially, and later reassembled on a conventional TV screen or facsimile readout.

The CCD thus becomes the basis for an all-solid-state TV camera, eliminating the need for the bulky vacuum tube and scanning electron beam required by standard TV cameras today.

CCD cameras offer a number of other advantages intrinsic to solid-state designs, including long life, low power consumption and remarkably small size — about the size of a pack of cigarettes. They are compact enough to be hand-held, and offer superior performance features.

Unlike vacuum tube cameras, CCD cameras require no warm-up time, as they are not susceptible to "lag" (smearing caused by bright moving areas) or to "burn-in" (damage that can be caused by intense light or electron beam bombardment). Finally, CCD cameras feature much greater sensitivity — a big advantage for TV pictures made in low-light conditions.

In 1971, Bell Labs unveiled the world's first black-and-white CCD camera. In 1972, it followed with the first CCD colour camera, and after three years of additional refinements, announced a CCD camera capable of meeting the resolution requirements of commercial TV broadcasting.



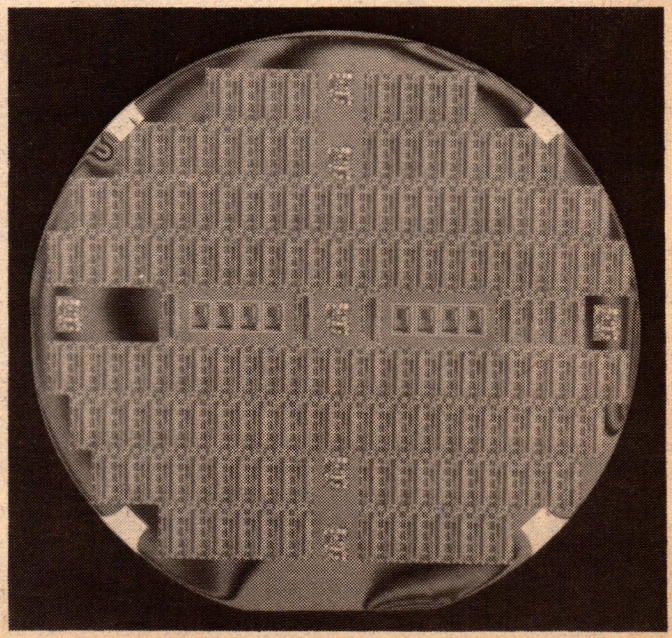
Bell Labs process engineer John Heilig removes two lots of CCD wafers (48 in all) from an oxide growth furnace. The CCD chips are destined for use as compact, economical replacements for filters in telephone switchgear.

CCD imagers have also been developed for possible future use in videotelephone systems and equipment for transmitting high-resolution print, drawings and photographs over telecommunications networks.

In the meantime, more specialized applications have been numerous. CCD cameras were introduced commercially in 1975 by companies licensed by the Bell System. They have been used by the military for aerial reconnaissance, and astronomers have put them to work in powerful telescopes to produce extremely detailed images of distant planets. NASA plans to use CCD imagers for the first Jupiter Orbiter Probe, as well as for the Space Telescope Project — both scheduled in 1983.

In the future, CCD cameras could spawn a new generation of "minicameras" for TV broadcasting, and they could eventually find use in home video cameras and entertainment systems.

CCDs also have tremendous potential as memory devices. In the early



This CCD wafer, 75mm in diameter, contains 169 CCDs. Each wafer is patterned for a particular CCD filter circuit.

SAVE $15.00

Model 8100 Frequency Counter Kit

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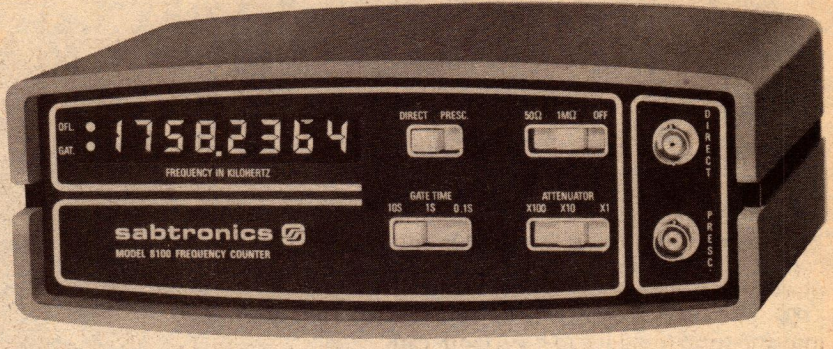
- High Sensitivity
- Resolution to 0.1Hz



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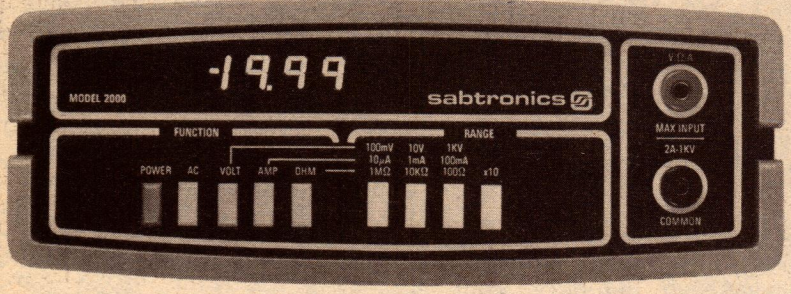

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- Basic DCV Accuracy: 0.1% ±1 Digit

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Bright future for charge coupled devices

1970s, Bell Labs built prototypes to demonstrate the feasibility of CCDs for information processing in telecommunications — an application that also extends to commercial computers. Since charge packets of information can be stored, regenerated, and moved about sequentially with a CCD, the device functions as a shift register and can be used to construct a recirculating electronic memory.

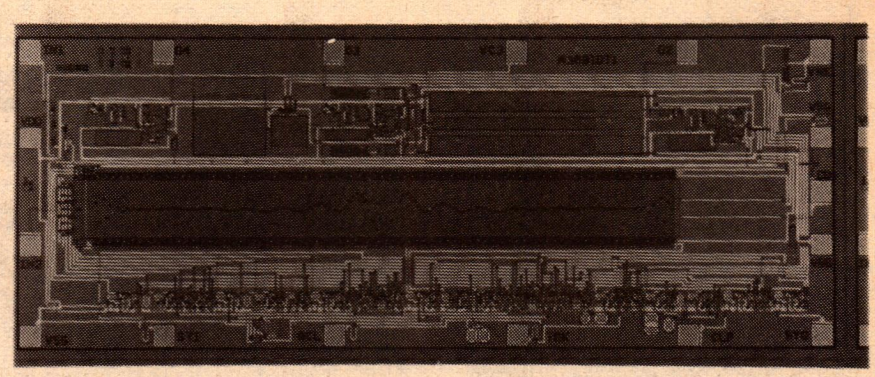
Today's CCD memories feature high information-storage capacity, and can be made with the same advanced technologies used to produce microprocessors and state-of-the-art integrated circuit memories.

The first commercially available CCD chips, introduced in 1975, had capacities of 9,000 bits. In 1976, 16,000-bit chips appeared, and in 1977 the figure jumped to 64,000 bits per chip. Some industry observers foresee a market growth rate of nearly 100 per cent for CCD memories over the next several years, and a potential market totalling $120 million by 1981.

High density in electronic memories translates directly into small size and lower information-processing costs. As a result, systems designers may find CCD memories attractive contenders for future products and systems.

But although CCDs have won preeminence among solid-state imaging devices and are gaining momentum as memories, their greatest impact may lie in the area of signal processing for communications systems.

In analog applications, the high capacity, low cost and modest power requirements of CCD chips can be exploited to make significant improvements in many types of communications devices. These include delay lines — circuits whose outputs are identical to their inputs, but delayed in time; multiplexers — circuits that combine many signals in a single transmission medium; and electrical filters — circuits that transmit some frequencies and reject others.



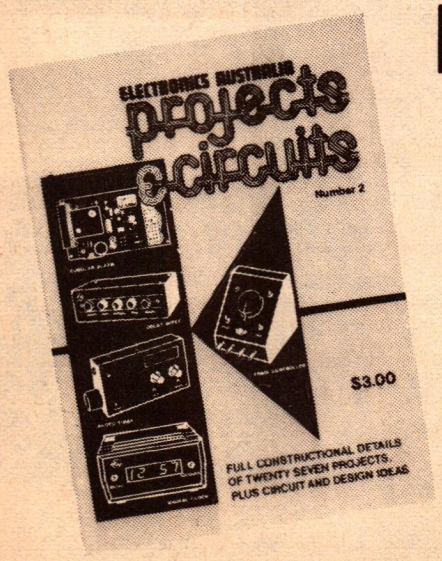
Enlarged view of Bell Labs designed CCD filter shows chip features in detail. Chips are made at the Bell Labs-Western Electric facility in Allentown, Pasadena.

The voice-frequency electrical filter is one of the most basic communications circuits and provides a good example of how CCDs could be used. Such filters are critical components in modern systems that carry tens of thousands of phone calls along a single transmission path. The filter confines each voice channel to a certain frequency range and helps prevent noise, crosstalk and other types of interference.

In the Bell System, millions of these filters are manufactured by Western Electric each year. Though their design and performance have been greatly improved in recent years, both through developments in integrated-circuit technologies and in piezoelectric devices, the CCD promises to reduce their size and cost still more.

Since CCDs use the same technology as conventional MOS memory circuits, the CCD device can be placed on the same large-scale integrated circuit chip used to perform other functions in the system. Other filter-design techniques require a separate technology.

With such advantages in mind, Bell Labs systems designers may evaluate CCDs for other signal processing functions in new switching, transmission and customer equipment. CCDs have come of age, and they are going to work for the Bell System.



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Practical uses for the Wiegand effect

An unusual magnetic switching effect with a wide range of potential applications has been developed by The Echlin Manufacturing Company, Connecticut, USA. Called the Wiegand effect, the new technique makes possible the generation of large, narrow and consistent voltage pulses using only two small permanent magnets, a pick-up coil, and short lengths of specially treated wire.

by BRIAN DANCE

The Wiegand effect has application almost anywhere a pulse has to be generated and, in most cases, will do the job better than existing methods. Design simplicity coupled with non-contactless operation make it ideal for a wide variety of industrial process control uses, together with a myriad of commercial applications. Let's see how the Wiegand effect works.

The Wiegand effect wire is made from a specially prepared ferromagnetic material about 0.25mm in diameter and about 10mm in length. It is worked in a special way so that it has a magnetically soft inner core and a magnetically hard outer "shell". The magnetically hard material requires a much greater magnetic field to reverse its direction of magnetisation than does the soft inner core.

The application of an appropriate magnetic field causes a very large change of magnetic flux with respect to time in the Wiegand Wire, inducing a voltage pulse in a pick-up coil. This process is graphically illustrated in Fig. 1. At A, the wire is saturated with both shell and core magnetised in the same direction. The application of a small reverse field causes the core polarity to switch as shown in B. At A', the positive field has caused the core to switch back to its original direction.

It is this rapid switching of the direction of magnetisation that causes a pulse to occur in the pick-up a coil. The pick-up coil typically consists of 1000-2000 turns, and can be wound directly on the Wiegand wire to produce a voltage pulse in the range 0.5-12V and 20us wide at half-amplitude. A typical pulse is shown in Fig. 3.

Fig. 2 shows an asymmetric drive field waveform, and the resulting Wiegand pulses. The large positive pulses occur when the core polarity switches from B to A' as shown in Fig. 1. The small negative pulse occurs when the core polarity switches from A to B. Fig. 3 shows the positive pulse on an expanded time scale.

The external field, by the way, produces little voltage in the pick-up coil, since this field changes relatively slowly compared to the field produced by the Wiegand wire.

When pulses of both polarities are required, a symmetric drive field is employed. Fig. 4 shows a symmetric drive field waveform, and the resultant Wiegand pulses. The pulses generated under this drive are equal in amplitude and opposite in polarity, and are about one-fourth the amplitude of the positive pulse generated by asymmetric drive.

The great advantage of the Wiegand effect is its simplicity, since one can employ quite small permanent magnets and produce output pulses without any source of power. Although one can wind the pick-up coil directly onto the Wiegand wire, as indicated above, it is often more convenient to combine the coil with two small permanent magnets as part of a read head. The resulting output pulses can be used to directly trigger a thyristor or to control a power transistor, as they are of large amplitude and the output impedance is low.

Wiegand systems also have the advantage of being contactless (no mechanical wear), and are therefore able to operate for long periods without maintenance. In addition, they have a high-signal-to-noise ratio, are unaffected by temperature variations between —196°C and +260°C, and will produce highly consistent output pulses at any speed.

Applications of the Wiegand effect are numerous and include use in such fields as automotive ignition systems, credit and ID cards, keyboard switches,

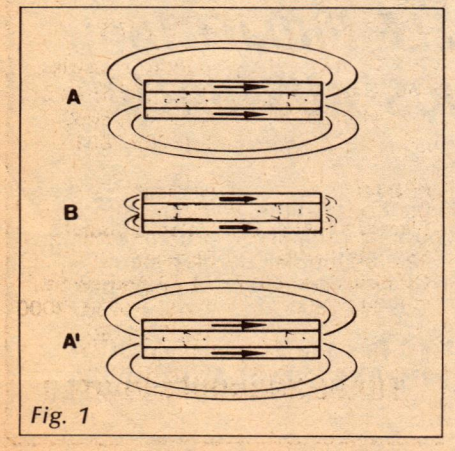


Fig. 1

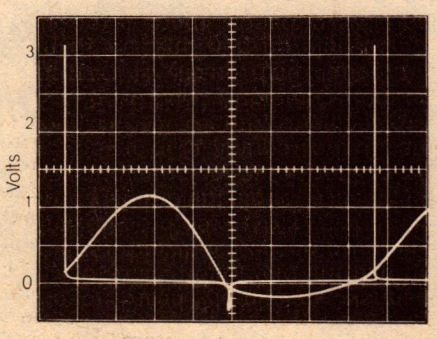


Fig. 2: asymmetric drive field and resulting Wiegand pulses. Timebase setting is 2ms/division.

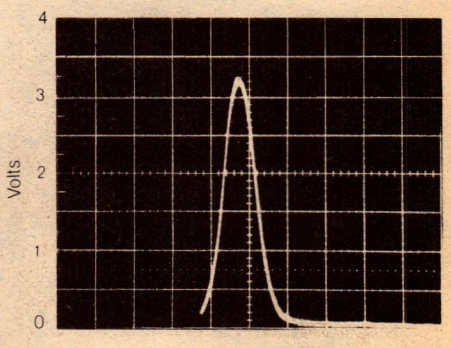
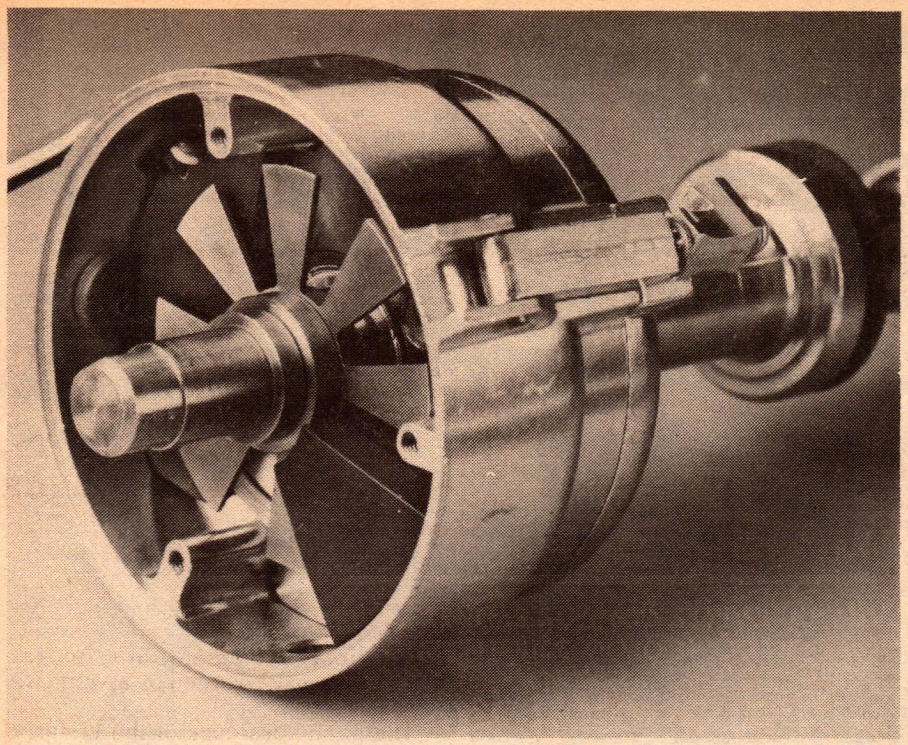


Fig. 3: positive Wiegand pulse of Fig. 2 on an expanded time scale. Timebase setting is 20us/division.



Practical vehicle ignition distributor based on Wiegand effect components. Photo courtesy R. L. Mourey Associates, Bethany, Connecticut.

flowmeters, process control, and proximity detectors. Already, the Wiegand effect has found application in plastic ID cards which secure access to restricted areas.

The plastic cards were issued to 150 employees of one US company. Wiegand wires embedded in these cards allowed card holders to pass through special turnstiles equipped with card readers, thus providing access to subway transport. Canadian airports are also using Wiegand cards.

The Wiegand wires embedded in such cards are arranged in two rows, one of these rows determining the positions of the 0's and the other row that of the 1's. A readout head with a common pick-up coil reads pulses from both rows of wires. These output pulses are then fed into an electronic decoder circuit which determines whether the card presented is acceptable.

Wiegand cards are more expensive than similar cards containing a magnetic stripe, but the Wiegand readout equipment is cheaper and is said to provide better security.

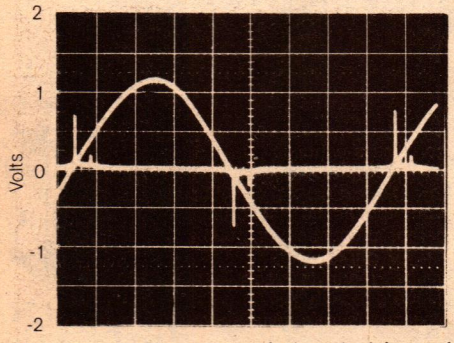


Fig. 4: symmetric drive field and resulting positive and negative Wiegand pulses. Pulses have equal amplitude.

An obvious use of the Wiegand effect is as a timing device in an automotive ignition distributor. One new system already developed by Echlin uses a Wiegand wire with a copper sensing coil wound on it, two magnets and a rotating vane of four, six or eight fingers (depending on the number of cylinders). The Wiegand wire and the reset magnet are located in one arm of a U-shaped block. The drive magnet is located in the other arm.

As the vane fingers rotate between the arms the effect of the drive magnet is interrupted, causing the Wiegand wire to induce a pulse in the sensing coil. The pulse is used, in turn, to fire a power transistor, which then fires the ignition coil.

Because the Wiegand effect is insensitive to temperature variations, problems caused by high underhood temperature are eliminated. In addition, the electronic "black box" associated with the Echlin distributor uses only eight components, compared with 25-30 in existing electronic systems. The system is both simple and reliable, and produces the same large output pulse at any speed from cranking to maximum RPM.

Other possible automotive applications of the Wiegand effect include tachometers, fuel-flow meters and anti-skid braking systems. Wiegand products are obtainable from The Echlin Manufacturing Company, US Route 1, Branford, Connecticut 06405, USA.

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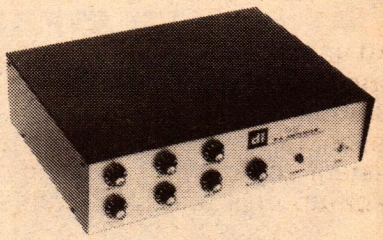

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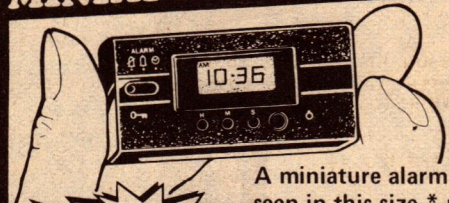

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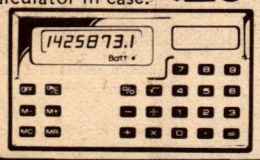

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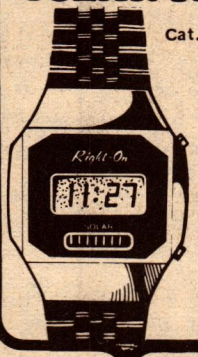

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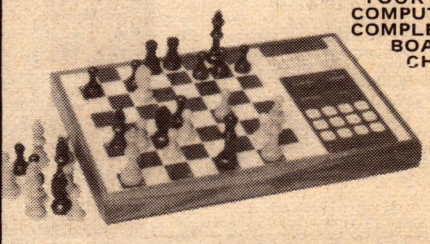

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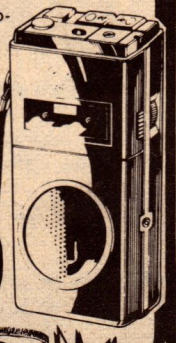

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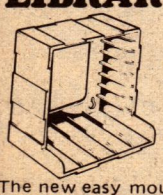

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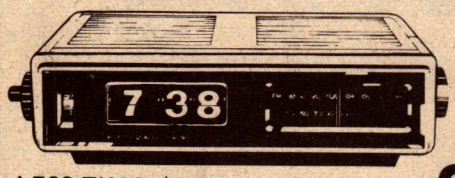

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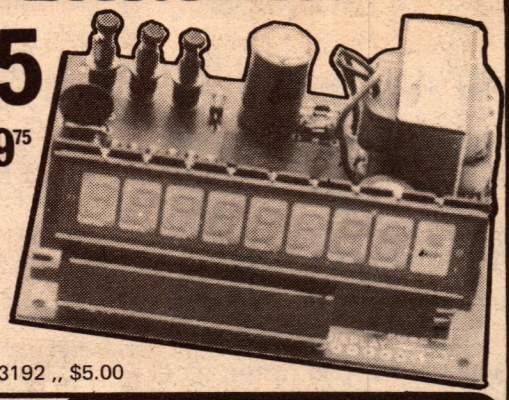

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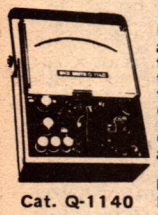

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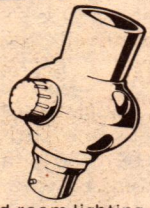

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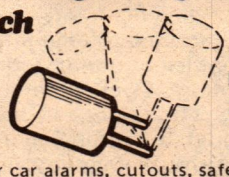

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PARTS FOR NEW KITS

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Forum

Conducted by Neville Williams

THE LOGIC BEHIND HYBRID CARS

The cover picture on our September '78 issue has prompted a certain amount of comment, ranging from cracks about perpetual motion to more serious debate as to whether the idea of a hybrid petrol/electric car is — or is not — soundly based. We can't add all that much but here goes, anyway:

The picture showed a rather pretentious looking sports car which, according to the caption, is driven by a 1.86kW (approx 2.5hp) electric motor at each rear wheel. The motors are powered from four heavy duty 12V batteries, kept charged by a petrol driven motor/generator in the "boot". The statement followed that fuel consumption could conceivably be cut to half that for a normal 2-litre car.

One immediate comment was to question the concept of driving around with a "lawnmower engine" blasting one's ears! I, personally, would not relish the idea either but I fancy that there are more appropriate frames of reference than a domestic two-stroke mower! For example, the most recent portable motor/generator sets that amateurs and others take on field days look — and sound — more like pieces of electronic equipment than petrol engines.

I don't see noise level as any real problem.

I think we can dispose, too of the "perpetual motion" bit. Certainly no one at this end entertained any such notions in respect to the particular vehicle. That would have been too much!

Indeed, we've lost count of the number of times would-be inventors have come up with the suggestion for an electrically driven vehicle which recharges its batteries from a generator coupled to the wheels or to the main drive motor.

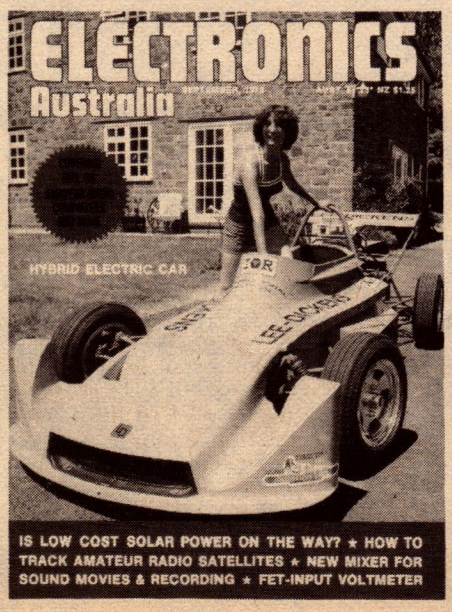
Unless someone can repeal the laws of physics as we now understand them, it takes more power to run a motor driving a generator than a generator can return to a storage system. So a motor/generator loop, or a motor/battery/generator loop cannot even sustain itself, let alone have power left over to propel a vehicle!

Nor can the situation be redeemed by regenerative braking or by charging the battery while running down hills. It takes more energy to attain a certain speed or a certain elevation than can be recovered from the reverse process.

No, in accepting the picture for publication, we didn't fall for a thinly disguised perpetual motion gag!

In fact, the information supplied with the picture was rather sparse but, as we understood it, the thinking ran something like this:

For all its convenience and user appeal, a petrol automotive engine is, on average, an inefficient unit in terms of fuel consumption. Over a limited range of driving conditions, it may show up well enough but rarely can the average driver on the average journey stay within this range. Outside it, the efficiency drops away and, of course, while the vehicle is decelarating or stationary, the engine is consuming fuel to no purpose. Add to this the power losses in the transmission system, particularly if automatic, and the overall picture is hardly a bright one.



By contrast, if one envisages an internal combustion (IC) engine coupled directly and only to a generator, and operating at a constant speed (or over a limited range of speed) its design can be optimised for that role. Its fuel efficiency would benefit markedly, with the likely option of using other than high octane petrol. And, irrespective of whether the vehicle was running downhill or stationary, the unit would still be charging the storage batteries. It need never be using fuel to no purpose. Furthermore, on a downhill run, there would be the option of regenerative braking.

Admittedly, the energy delivered by the engine would have to traverse the generator, the battery, the control system and the electric drive motors before it ultimately reached the wheels and this may look to be a rather daunting (and lossy) chain. In fact, it may be a lot less than one might expect, given modern electrical and electronic technology.

The key question that emerges is whether an optimally designed motor, driving the wheels through an electrical chain, will turn out to be more fuel efficient than a conventional engine operating through a conventional (and also lossy) mechanical transmission. The sponsors of the hybrid car obviously believe so and, whether or not one is inclined to agree, their contention is not lacking in logic.

The sponsors are apparently looking for a 2:1 improvement in fuel consumption but it is unclear whether this is for equal performance criteria or simply on the basis of how much fuel would be used in travelling from point A to point B, without reference to the time taken.

A factor with a hybrid, or other electrically propelled vehicle, is that the driver may have no option but to travel in a fairly sedate fashion. The comparison with conventional vehicles might be less favourable if the latter were governed back in some way to a similar order of sedateness!

Quite by chance, I came across a report dealing with automotive electronics in a back copy of "RCA Engineer" (Aug/Sept 1976). It was compiled by Gerald B. Herzog, Staff Vice President, Technology Centres, of the RCA Princeton Labs.

Two points raised in the report are particularly relevant to the foregoing.

The first is that idling is the most wasteful of all modes of operation in a conventional vehicle. It most obviously occurs at stop signs, traffic lights and traffic hold-ups. Less obviously, it occurs every time a driver lifts his foot off the accelerator to slow down for one of

the above situations, or merely in an effort to maintain a constant average speed.

According to Herzog, in city traffic, an automotive engine may be actually or virtually idling for between 10 per cent and 60 per cent of the journey time.

The position is aggravated in a large vehicle loaded up with air conditioning and other energy absorbing gadgetry. Not only does it impose a permanent load on the engine but it often induces mechanics (or drivers) to set the idling speed high to minimise any risk of engine stall. I quote Herzog:

"The idle speed is often set so high that the car will travel at about 10mph on a level road, and faster if the choke is closed. That means that our brakes are fighting the engine as we try to stop at each stop sign."

The report also explores the enormous dynamic range over which a normal automotive engine has to operate. The owner of a large car may demand a 200hp engine for "performance" reasons, yet he is likely to invoke the available power for only one per cent of the driving time. When driving on a level road at 60mph he will be using about 20hp — 10 per cent of a maximum power available. For 43 per cent of the time he will be using less than that again for actual propulsion!

The problem is that, while being called upon to deliver such modest propulsion power for much of the time, a 200hp engine is consuming a significant amount of fuel merely to keep itself going — overcoming mechanical losses and, in particular, "pumping" losses. This latter includes the energy expended in trying vainly to suck air/fuel mixture through a highly constricted throttle opening.

This leads Herzog into speculation about the possibility of transmission systems with an infinitely variable drive ratio. This would allow vehicle speed to be controlled primarily by the transmission system ratio, leaving the motor to follow other dictates. In these circumstances, the designers would be better able to deal with problems of fuel efficiency — and exhaust pollution.

It would involve a radical departure from the present concepts of manual or automatic transmission, and an almost certain reliance on electronics (microcomputers?) to monitor, calculate and impose the optimum relationship between engine speed and road speed on a continuous basis. Herzog suggests the possibility of the driver being able to switch the system instantaneously to emphasise fuel economy for city driving, modest performance for country touring or get-up-and-go for urgent needs.

It is not clear what kind of "electronic transmission" Herzog had in mind but it is reasonable to speculate whether the role might not be filled best by the kind of electrical system referred to earlier.

Further light on the subject of electric and hybrid vehicles has been shed by a recent report from the French Renault Group. They say that they have been actively researching the field since 1973 and have now made co-operative agreements with two other French firms which will give them access to motor, battery and electrical control technology.

Their main interest is in special purpose electric vehicles, including a trolleybus which carries on-board batteries and an on-board diesel motor/generator set. On electrified sections of a route, it would draw its motive power from the lines, using the same source to top up its batteries. However, it would be able to extend or vary its journey, relying on the on-board batteries and the diesel driven charger.

Renault say that electric propulsion presents more of a problem in ordinary cars because of the different ideas and demands of the private motorist. However, Renault have apparently moved positively into the electric propulsion area and, if a market for private electric vehicles should open up, they will presumably be ready for it.

FM & IGNITION HASH

To change the subject, the accompanying letter from a Victorian correspondent is in response to some remarks made in our September issue. A reader had asked why it was that his domestic FM tuner, supposedly capable of "crystal clear stereo FM music", emitted a "machine-gun rattle" of ignition interference every time a car went past his home.

We maintained that it shouldn't happen in a suburb within the service area of major FM transmitters, provided the tuner was not being cheated of signal by a heavily shielded location or by an inadequate antenna system. If there were no such problems, the tuner itself may be to blame for one reason or another.

We made the point that the correspondent had entered no complaint about interference with his TV sound, which also involves an FM transmission, in one case from the very same tower in North Sydney.

We've had no reason to modify these remarks nor have we had other supporting complaints, as yet, about ignition interference into domestic FM tuners. They may yet come to light, of course, and form some kind of a pattern.

The problem raised by N.H. is really a quite different one, in that he is concerned with ignition interference into FM receivers actually installed in road vehicles. There are "no exceptions", he says, with the no in his original letter underlined for emphasis.

My mind goes back to the start of the mobile radio era, immediately follow-

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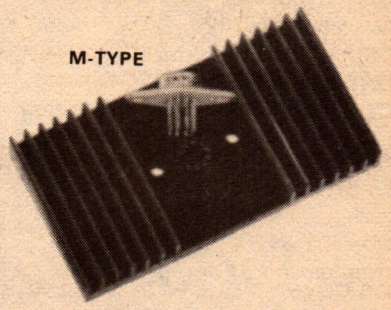

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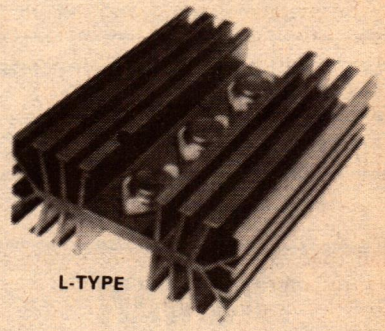

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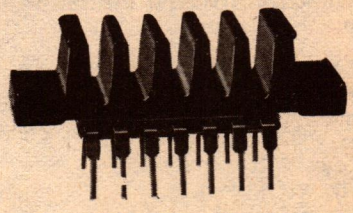

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ing the end of World War II. Those persevering with AM systems soon found themselves fighting a defensive battle against the champions of FM — the system which tended inherently to reject ignition and other interference. However, field tests at the time did not establish a difference in black and white terms: noise and no noise.

The difference was usually one of degree, with FM exhibiting some noise in fringe areas but not as much as AM. The "voice out of silence concept" proved to be a myth.

Talking with radio amateurs who use a lot of FM mobile gear on 52MHz and 144MHz, I find these recollections reinforced. Particularly on 52MHz, some interference from the ignition and other electrical gadgetry in the vehicle is accepted as par for the course. However, provided the interference level is not such as to obliterate weak, incoming signals, the amateur operator doesn't lose too much sleep over it.

He accepts philosophically the fact that there will be areas where the available signals are much weaker than others.

In the light of this, it is perhaps not surprising that ignition interference should be a potential problem with mobile FM broadcast receivers, operating on a band just above the region where ignition interference is said to peak.

In fact, fresh from last month's article on induction transmission for hearing aids, I found myself wondering whether there may not be a very similar situation in respect to family cars — a radio inductive field within the immediate vicinity of the vehicle set up by the wiring. Within this confined but intense field one would be trying to operate a wide-band FM (or FM/stereo) broadcast system, from antenna to loudspeaker(s). Certainly the potential for interference is there.

And, as distinct from amateur radio operators, the criterion for satisfactory FM broadcast reception is not just a level of hash low enough to be overridden by a voice. The criterion is no hash, full stop!

N.H., who says that he is involved in the installation and servicing of car radios, appears to regard "no hash" as unattainable with the receivrs, the cars and the FM signals available in Melbourne.

I wonder how many others share his views, whether in Melbourne or elsewhere?

I wonder, too, whether close enough attention is being paid to the matter of antenna orientation, as mentioned in the letter. Amateurs operating on 146MHz are acutely aware of the loss of signal which can result from incongruous polarisation. Yet we have the situation of large numbers of FM receivers, obliged to use a vertical rod, having to cope in many cases with horizontally polarised transmissions.

Ignition hash ruins FM/stereo

Dear Sir,

This letter is prompted by your reply to the query by J.R. in the September edition of "Forum". I am involved in the installation and servicing of car radios, and have recently noticed an upsurge in demand for AM/FM receivers for use "on the road".

However, with no exceptions, I have found it almost impossible to obtain interference-free reception of Melbourne's FM stations while any particular vehicle has its ignition on; in particular the ABC-FM transmitter which gives excellent city coverage can be mutilated beyond tolerance as close as 25km to the transmitter.

Since I do not want to make this letter overly long, I would add that extensive tests on the problem have vindicated that the ignition interference appears to enter the receiver via the whip aerial; extreme suppressing of the supply leads does not appear to have any significant effect.

I realise that FM transmissions are horizontally polarised, but tests with strip dipoles on the windscreens did not give any dramatic reduction in ignition interference. I hasten to add that, of course, some vehicles are worse than others; and certain receivers have better noise rejection than others, but the problem still exists.

The problem is why should an FM car receiver be so (apparently) intolerant to impulse interference, especially when an otherwise good noise-free stereo signal is being received?

In this regard I would refer you to the book, "Radio, TV & Audio Technical Reference Book" edited by S. W. Amos, pages 22-47, 22-48. It would appear from this article that even manufacturers admit that the ignition noise problem exists and have created circuitry not to "cure" the problem, but rather avoid it.

N.H. (North Carlton, Vic.)

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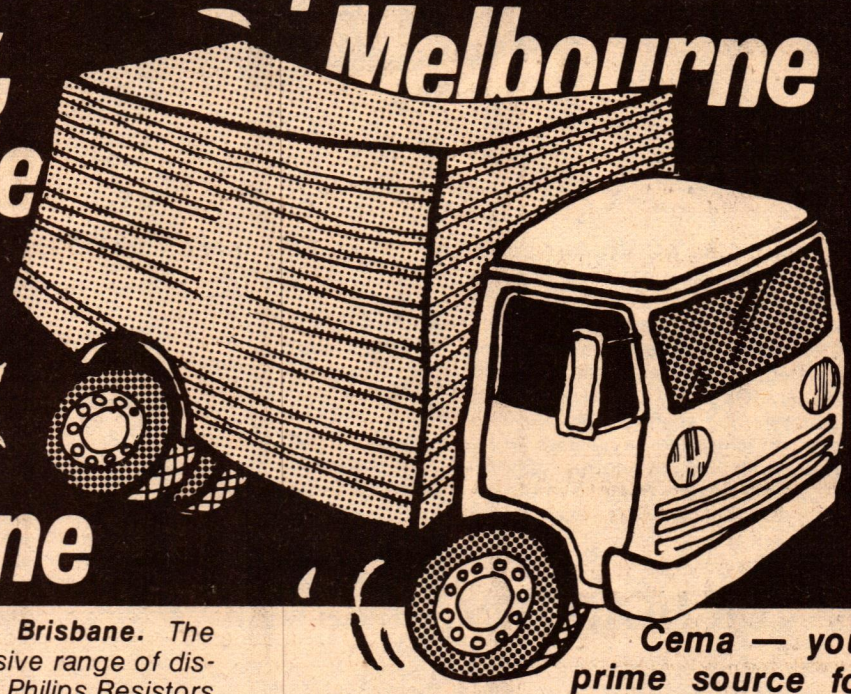

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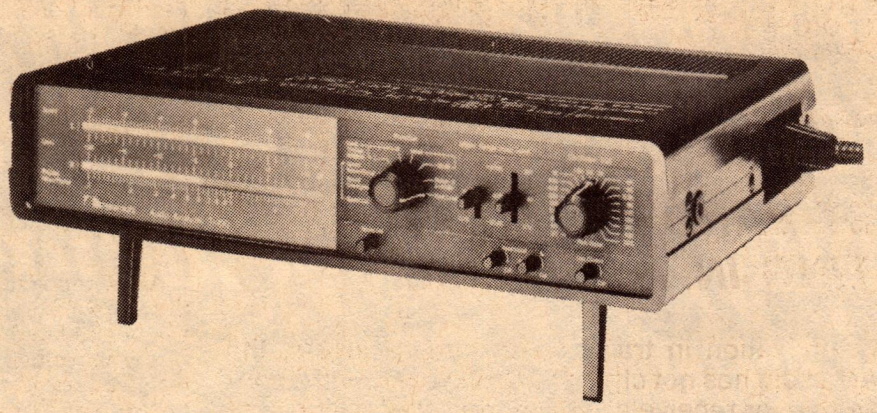

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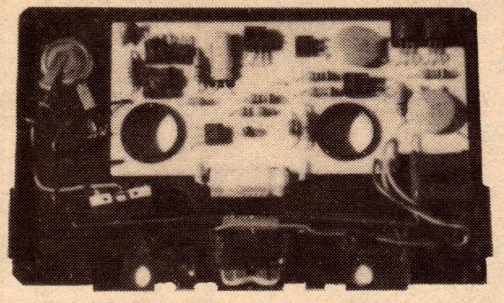

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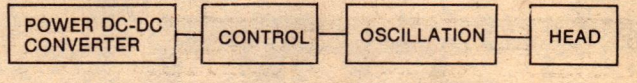

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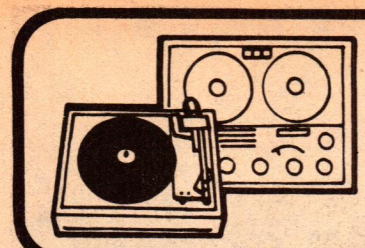

Hi Fi News

BROADCAST BAND AM-STEREO IS STILL WAITING IN THE WINGS

Despite continuing innovation in transmitters and receivers, the technical basis of AM radio has not changed in 50 years. Will it continue in its mundane role, or receive a very needed shot-in-the-arm from, say, the incorporation of a stereo facility?

by BRIAN DANCE

Long, medium and short-wave broadcasting using AM (amplitude modulation) became the established system during the first third of this century and is still widely used throughout the world for basic broadcasting.

For a variety of reasons, some to do with propagation conditions, and some to do with receiver design, AM broadcasting has gravitated into the role of a medium fidelity service, limited to monophonic (i.e. single channel) sound. The ever growing numbers of high fidelity enthusiasts therefore tend not to take it seriously as a program source, except for weather, news and sporting results.

This has left the way wide open for FM (frequency modulation) broadcasting to become established as a system which can provide high fidelity stereo programs, with a generally low level of atmospheric and electrical noise interference.

The method that has been adopted for FM/stereo broadcasting is fully compatible in that a "multiplexed" signal can be resolved in stereo by a stereo receiver, or in mono by a conventional monophonic receiver. In the latter case, the left and right hand channels are simply heard together through the one loudspeaker.

Because of the bandwidth required, high fidelity FM/stereo broadcasting is not practical within the ordinary broadcast or short-wave spectrum but is confined to the frequencies in or above the VHF segment with 88-108MHz being the most commonly used band.

Although high quality FM/stereo is not possible on the long, medium or short wave bands, there is no fundamental reason why AM stereo should not be transmitted in these bands.

Although the quality of the received signal will not be as good as that obtained when high quality VHF FM/stereo systems are employed, AM stereo transmissions could be used to cover regions where adequate VHF coverage would be difficult to provide.

It would also be very useful for car radio stereo systems, where the antenna used is poor compared with those used in a home. The use of AM stereo would also avoid the multipath distortion which can occur in FM stereo reception.

In the USA, five different stereo systems have been proposed and it rather appears that little further progress will be made until one of these systems is selected as the standard one, likely to be used throughout the world.

All of the systems are compatible in the sense that the same transmission can be used to provide mono reception of the left-plus-right signal in the normal way, as well as providing stereo reception for suitably equipped receivers.

Some people are very sceptical as to whether AM/stereo transmissions are worthwhile, but others are very enthusiastic. After all, if AM/stereo is adopted, it would be the first really major development in broadcasting on the lower frequency bands since the 1920s!

The organisations which have stimulated interest in AM/stereo in the USA are the NAB (National Association of Broadcasters), the NRBA (National Radio Broadcasters' Association), the EIA (Electronic Industries Association) and the Broadcasting, Cable and Consumer Electronics Society of the IEEE. These organisations were represented in the NAMSRC (National AM Stereophonic Radio Committee) which was founded on September 24, 1975. In December 1977 the AM/stereo report of this Committee was presented to the US Federal Communications Commission.

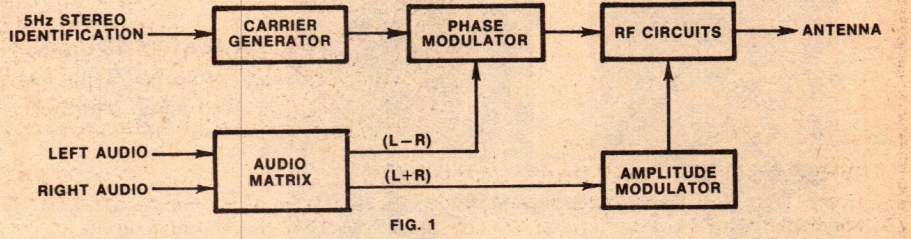

FIG. 1

Block schematic of a Magnavox style stereo AM transmitter. It is compatible in the sense that a normal AM receiver responds to the amplitude modulation but substantially ignores the phase modulation component.

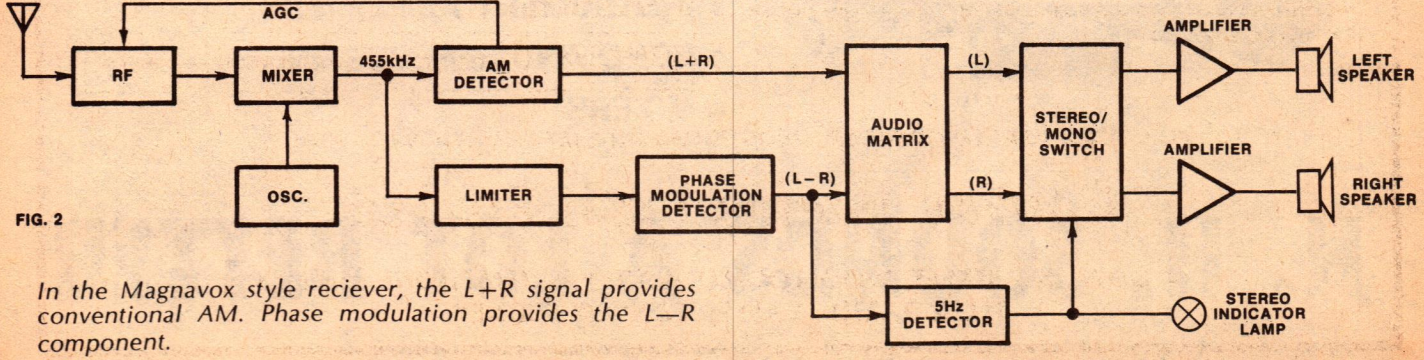

FIG. 2

In the Magnavox style reciever, the L+R signal provides conventional AM. Phase modulation provides the L—R component.

H||H electronic

What P.A. Amplifier sells itself? —The H.H. MA100

A compact and portable powerful mixer amplifier which has achieved outstanding success in Europe, it features: Five separate controllable channels. — Individual Bass, Treble Volume and push button Reverb on each channel. — 10 inputs (i.e. two per channel) available. — Master Volume, Master Presence and Master Reverb control the final mix to the integral 100 watt power amplifier. — Superb crystal clear sound for the vocalist.
Additional features include Auxiliary Input for connecting two MA. 100's together giving ten channels (i.e. twenty inputs), Echo send and return and Slave output connections.

MA100: 10 inputs - 5 channels - 100 watts
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The five possible main systems at present being considered are known after the names of their proposers:
(i) The Belar System
(ii) The Magnavox System
(iii) The Motorola System
(iv) The Harris Broadcast Products System
(v) The System proposed by Kahn Communications Inc and the Hazeltine Corporation.

As distinct from FM/stereo transmission, it is not possible to modulate a sub-carrier wave with the left-minus-right (L-R) signal, since the available bandwidth is much too limited at the transmission frequencies concerned for any sub-carrier frequency to be employed. The proposed systems therefore employ double modulation techniques in which both the (L+R) and the (L-R) signals are modulated onto a single carrier. Unfortunately this leads to some distortion in the received (L+R) signal.

The basic techniques used can be summarised as follows:

In the Belar and the Magnavox system, the (L+R) signal is amplitude modulated onto the carrier wave frequency, but an (L—R) signal is frequency modulated (Belar) or phase modulated (Magnavox) onto the same carrier.

The Motorola and the Kahn-Hazeltine systems also involve a (L+R) amplitude modulated signal, but the (L—R) signal is transmitted in phase quadrature (that is, 90° out of phase) with the (L+R) signal on the same carrier.

The Harris Broadcast Products system is rather similar to the Motorola and to the Kahn-Hazeltine systems, but the phase angle difference between the (L+R) and the (L—R) signals is only 30°.

(Those who have followed the arguments about recording quadraphonic signals on disc records, will recognise the phraseology!)

There are differences in the signal-to-noise ratios, distortion levels, etc. provided by the five systems, but circuit complexity is also a vital consideration. Basically the distortion levels seem to be rather higher in the systems using frequency or phase modulation than in those employing phase quadrature or the 30° phase difference, but the latter systems tend to be considerably more complex.

The principle of a Magnavox stereo transmitter is shown in Fig. 1. The left and right audio signals are fed into an audio matrix circuit which produces the (L+R) and (L—R) signals. The (L+R) signal amplitude modulates the carrier in the normal way, whilst the (L—R) signal is fed into the phase modulator circuit. A 5Hz stereo identification signal is also fed into the system where it frequency modulates the carrier. An additional circuit (not shown in Fig. 1) is used for equalising the time differences in the two parts of the circuit so that the (L+R) signal takes the same time to pass through the system as the (L—R) signal.

The block diagram of Fig. 2 shows the principle of a receiver designed for the Magnavox system. The (L+R) signal is obtained in the conventional way by using a standard type of AM detector, but the amplified signal at the 455kHz intermediate frequency is also passed to a limiter and then to a phase modulation detector; the latter provides the (L—R) signal at its output, together with the 5Hz stereo indication signal.

The (L+R) and (L—R) signals are fed into a matrix circuit which provides the left and right audio output signals; these signals are fed to the two power amplifiers which in turn drive the left and right loudspeakers.

The mono/stereo switching unit is operated by the 5Hz stereo identification signal so that the circuit operates in the stereo mode only when a stereo signal is present at a suitable level. The 5Hz stereo identification signal also controls the stereo indicator lamp.

A conventional mono AM transmitter would require only the blocks in Fig. 1 marked "Amplitude Modulator" and "RF Circuits". Similarly the receiver of Fig. 2 is more complex than an AM mono receiver which would require only the circuit blocks marked "RF", "Mixer", "Oscilllator", "AM Detector" and an audio power amplifier.

A system similar to the Belar type was suggested as long ago as 1959 by RCA. The block diagram of Fig. 3 shows the type of circuit used in the transmitter. No stereo identification signal is envisaged for use in the Belar system. The left and right audio signals are fed to an audio matrix circuit which uses them to produce the (L+R) and the (L—R) signals. The (L+R) signal is used to amplitude modulate the carrier in the conventional way. The (L—R) signal is passed through a pre-emphasis circuit of time constant 100us and is then used to frequency modulate the carrier with a maximum frequency deviation of ±1.25kHz.

A receiver suitable for the Belar type transmissions is shown in Fig. 4. The first converter changes the signal frequency to the relatively high value for AM use of 10.7MHz. Problems of unwanted image frequency interference are avoided by the use of this high first intermediate frequency, whilst the low second intermediate frequency of 260kHz provides the required selectivity against

The Belar system is broadly similar to the Magnavox concept but differs in its execution. Transmitter block schematic is shown at right.

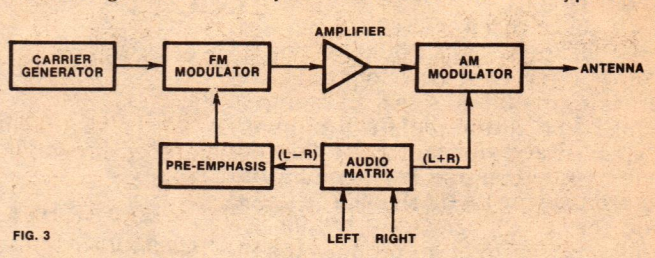


FIG. 3

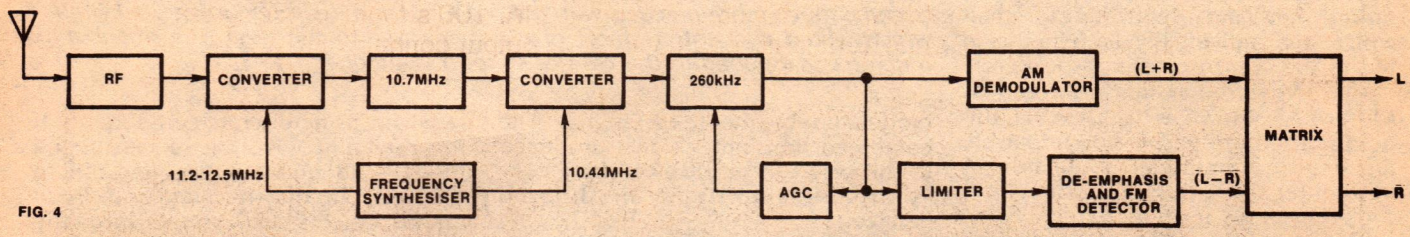


FIG. 4

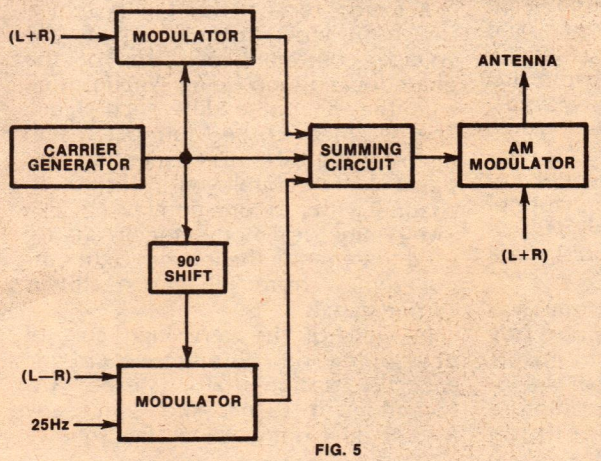


FIG. 5

Shown above is a block schematic of a Belar style AM/stereo receiver. It suggests a more complex approach than the Magnavox equivalent.

The C-QUAM transmitter (left) modulates the two stereo signals on to twin carriers displaced in phase. Receiver diagram is on the next page.

adjacent channel interference.

High stability of the frequency to which the receiver is tuned is provided by using a frequency synthesiser circuit to provide the locally generated frequency required by each of the converter circuits.

The Belar receiver circuit of Fig. 4 has two channels in its audio section. A conventional AM envelope detector provides the (L+R) signal at its output, whilst the intermediate frequency signal is also fed to a limiter, de-emphasis circuit and FM demodulator to produce the (L—R) signal. The (L+R) and the (L—R) signals are fed into an audio matrix circuit to produce the required left and right audio signals which are individually amplified and fed to the appropriate loudspeakers.

The AM/stereo system proposed by Motorola is known as "C-QUAM", this being an acronym for Compatible Quadrature-Amplitude-Modulation. A transmitter using this type of circuit is shown in block form in Fig. 5.

If one simply amplitude modulated the carrier with the (L+R) signal and put the (L—R) signal on a second carrier 90° out of phase with the first carrier, one would not have achieved a truly compatible stereo system; when the resulting signal was fed to a conventional AM detector, it would not give the (L+R) signal, but a mixture of the sum and difference signals with an intolerable inter-modulation distortion level of nearly 15%!

This type of basic system was therefore combined with a previously suggested "QUAM" system to enable "C-QUAM" to be developed. As indicated in Fig. 5, the already quadrature modulated carrier is amplitude modulated by the (L+R) signal. The combined transmitter signal produced in this way can be received by a conventional amplitude modulated receiver.

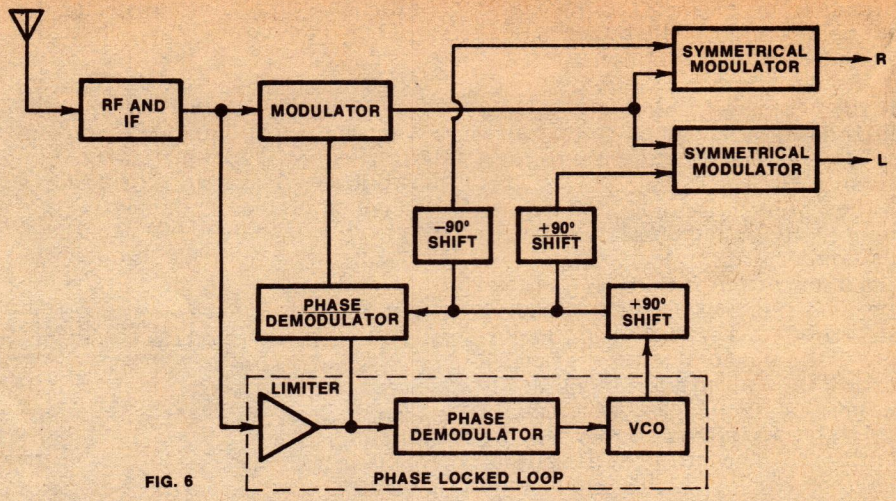


FIG. 6

While the C-QUAM receiver appears, at first glance, to be complicated, it would become much more practical with the production of dedicated integrated circuits which would concentrate most of the specialised circuitry on to a single chip, much has happened in the case of stereo FM tuners.

A stereo receiver for this system is shown in block form in Fig. 6, the voltage controlled oscillator of the phase locked loop being synchronised with the 90° phase difference signal. The designers of the Motorola system intend that a 25Hz stereo identification signal shall be employed in the (L—R) channel with a modulation level of 4%. Two symmetrical modulator circuits are used to generate the left and right output signals from the phase shifted carrier signals.

In view of the very high cost of developing new integrated circuits specially designed for stereo AM reception, it seems likely that any further development may first involve receivers using discrete components. If this preliminary work is successful and there is adequate public demand, it seems certain that the integrated circuit manufacturers will move into the market.

Indeed, they have already been investigating the possibilities of producing suitable devices, but it seems unlikely that a single integrated circuit could be used in more than two or three of the five proposed systems. If the FCC decide to recommend the use of one of the five systems, we could see rapid developments in AM/stereo devices, since it will be a multi-million dollar market for the integrated circuited manufacturers.

The receiver circuitry will be more complex than that of conventional AM receivers and therefore the use of monolithic devices will be an attractive proposition. It seems unlikely that any

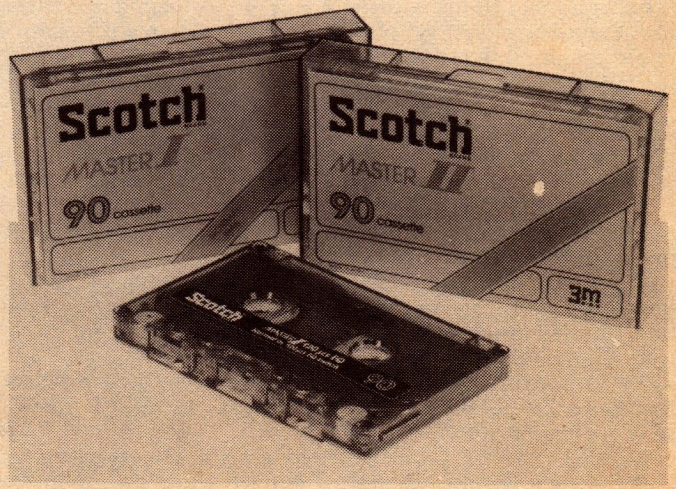
High claims for new "Scotch" Master Series cassettes

3M Australia Pty Ltd has released its new "Scotch" Master Cassette series, backed up by tests by a leading Australian university. The claim is that they are "unbeatable for performance and value in the premium or true hifi segment of the market."

The Scotch Master I cassette, featuring a "hot ferric" formulation, is intended to complement the "Normal" bias setting of quality recorders, and features a wide dynamic range, potential frequency response to 20kHz and a saturation level claimed to be "unbeatable".

Scotch Master II has been designed to replace chrome tapes and is optimised for the equivalent bias setting. It features high sensitivity, a frequency response to 20kHz, low distortion, and a better signal-to-noise ratio than other chrome equivalent tapes — claims which the university tests confirmed, using a Nakamichi 1000-II deck.

Both types of cassettes use precision moulded and screwed shells, of a transparent material, allowing the operation to be checked visually. They use "water wheel" roller guides, rotating on lubricated stainless steel axle pins to ensure minimum friction and noise.



For further information and performance data: David G. Dildine, Corporate Publicity Dept, 3M Australia Pty Ltd, P.O. Box 99, Pymble NSW 2073. Tel (02) 498 0033.

How BASF turn iron

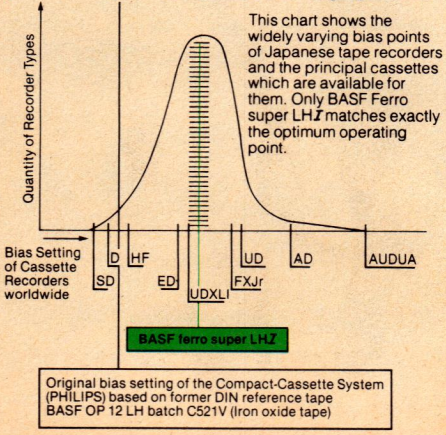
Man has always dreamed of the magic Midas touch that turns everything to gold. In the middle ages they searched for the philosopher's stone but nobody ever found it.

In 1934 in the world of sound, gold was discovered and BASF found it. In that year BASF produced the first magnetic tape and have built an international reputation for 'golden' technology and 'golden' sound.

In goes the iron, out comes the gold.

BASF have developed the finest possible quality Ferric Oxide cassette tape. The new BASF Ferro Super LH*I*.

This tape gives the best possible performance on equipment with Japanese bias setting and has the least background noise on the market for the iron position.
A higher recording volume is possible without interference. So when you play the iron you'll listen to the gold.

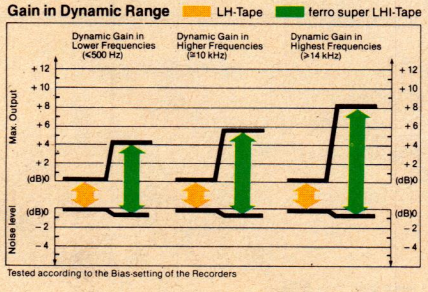


So what's in a new name?

Well, BASF put it this way.

BASF stands for the best possible cassette.

Ferro stands for the ferric oxide particles of equal shape that are evenly distributed over the mirror finish tape surface.



Super stands for the result, because you'll get more output over the entire frequency range.

L stands for Low Noise.
H stands for High Output.
I stands for One.

How else would you describe this cassette's superior place amongst its competitors?

The quality of the sound depends on more than the tape itself.

When the mechanical parts of a cassette let you down, you really feel let down. BASF have developed SM cassette tapes so you can rest assured this will not happen.

SM stands for Security Mechanism. Security mechanism to guide the tape accurately from one spool across the tape head and onto the other spool. Inside a BASF cassette there are two moulded and slightly curved plastic arms which guide the tape and accurately place every layer of tape on top of the last. The result is no 'wow' caused by the tape dragging on the cassette walls or being stretched by snagging tensions. And even when the cassette is dropped the tape is not disturbed inside.

SM
Security Mechanism
Patents Pending

and chrome into gold.

The quiet, efficient purring of the cassette inside its specially constructed shell makes for your listening enjoyment outside.

Switch over to chrome and switch into 'gold'.

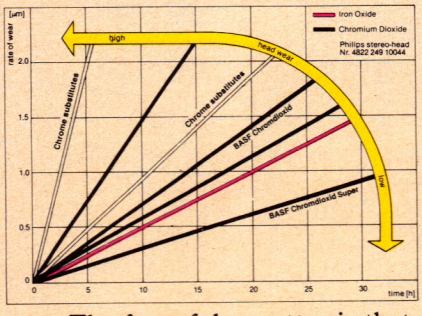
BASF have now launched their Chromdioxid Super cassette which has been produced from the best possible cassette technology in the world.

Golden sounds in anybody's language.

A great amount of controversy has surrounded chrome and it has usually been put out by manufacturers who can't produce the same quality themselves.

Head Wear of Cassettes

CrO_2 and other tapes recommended for CrO_2 bias setting and 70 µs equalization



The fact of the matter is that chrome dioxide gives a performance as good as a record. The tape surface is the same as used on videotape. And, BASF should know because they make videotape and no better tape surface is known at present.

When you play a BASF Chromdioxid Super cassette turn the switch of your equipment to the chrome setting and you'll hear really pure, original sound.

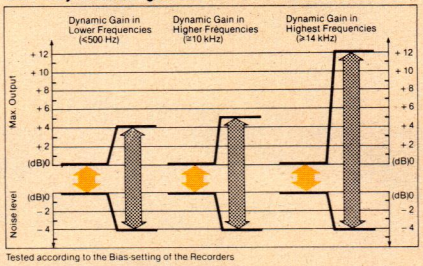
BASF Chromdioxid Super is simply the best possible quality cassette on the market for the chrome position.

What the Mercedes-Benz is to cars, this cassette is to cassettes.

When you have a reputation like BASF's you get used to people trying to copy your successes. But the true test is in performance which is where the BASF Chromdioxid Super really shows up.

As you can see in the diagram there is a considerable gain in the low, high and especially very high frequency dimensions.

Gain in Dynamic Range LH-Tape CrO_2 Super Tape



Tested according to the Bias-setting of the Recorders

This extends the useable frequency spectrum. The result is that the original recording keeps original and the BASF Chromdioxid Super uses the full capacity of the high quality recorders.

So, for equipment with the chrome switch this is the ultimate tape.

The BASF 'golden' story comes to life when you try the cassettes themselves. If you want the best from your cassettes you'll need BASF. BASF Ferro Super LH*I* and BASF Chromdioxid Super.

That's how BASF turn iron and chrome into gold.

BASF

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ULTIMATE.

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In any range of equipment there is a leader. One which sets the standard by which the others are measured.

With Philips Hi-Fi Stereo, the Hi-Fi Laboratories range stands at the very top.

These state-of-the-art Hi-Fi components, which were developed in America, offer precision craftsmanship, technical perfection and outstanding performance.

High-Fidelity Pre-Amplifier

The AH 572 High-Fidelity Stereo Pre-Amplifier is an ultra-low distortion (0.008%) two-channel unit featuring high-accuracy step detent controls, illuminated function readouts and touch switches with LED indicators for smooth, silent, sophisticated programming. It also includes adjustable phono input levels and a tape selector that provides five separate tape modes.

High-Fidelity Stereo AM/FM Tuner

The AH 673 High-Fidelity Stereo AM/FM Tuner incorporates touch switches with LED indicators and illuminated function readouts. Other features include ASNC (Automatic Stereo Noise Cancelling). Separate level controls for AM and FM. An FM interstation disturbance mute. And an exclusive AM centre-tuned meter for wide-band full fidelity AM reproduction.

High-Fidelity Stereo Power Amplifier

The 210 watts RMS per channel high-performance AH 578 High-Fidelity Stereo Power Amplifier completes the Philips Hi-Fi Laboratories range. It comprises high-accuracy step detent controls, touch switches with LED indicators and illuminated power meters and protection indicators. Also incorporated in the AH 578 are a sub-sonic filter, thermal and overload protection, and provision for connecting two pairs of loudspeaker systems.

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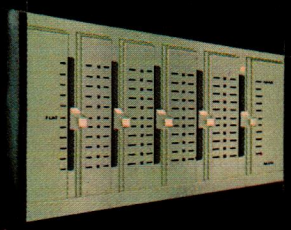
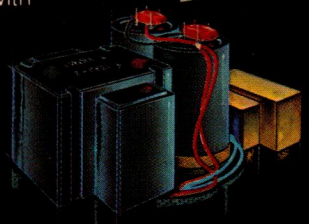
THE JVC SEPARATES.

Sensitive tuners, plus DC amplifiers that help eliminate sonic backlash.

If you've ever listened to a JVC music system with a separate tuner and amplifier, and thought, "One of these days..."

Well that day is here. The new JA-S44 DC integrated stereo amplifier, with its exclusive built-in SEA graphic equalizer and dual power meters, provides clean, uncannily-accurate music reproduction, with all the power you're ever likely to need.*

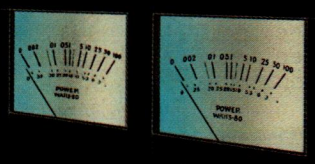




Our "Tri-DC" design in the JVC JA-S55 and JA-S77 further eliminates distortion-causing capacitors within the DC phono equalizer, DC tone control and DC power amplifier sections, providing frequency response from 5Hz to 100kHz (+0, −1.0dB). And they have dual power supplies—not one for each channel, as in conventional designs—but one for the Class A-operated preamp/tone control section, and a second which performs even heavier duty for the Class B-operated DC power amplifier section. This unique design practically eliminates both inter- and intra-channel crosstalk and distortion, or what we call "sonic backlash." The results: increased tonal definition and brilliance, especially with high-level transient signals.

The new JVC JT-V22 AM/FM stereo tuner is a standout in its class. With an FM front end that uses an FET RF amplifier, combined with a 3-gang tuning capacitor, the JT-V22 brings in the most timid FM stations and makes them sound as though they're just around the corner.

Or, if you're in an area where FM stations are a hairline away from each other on the dial, it delivers clear, interference-free reception. Then, to help you make sure you're on target, it has both signal strength and center-channel tuning meters.



Probably the most significant advance in recent FM tuner technology is JVC's Phase Tracking Loop circuitry in our new top model—JT-V77. This advanced circuit provides high signal-to-noise ratio as well as excellent interference rejection and freedom from multipath effects and adjacent channel interference. It's still another example of JVC's innovative engineering. But sounds speak louder than words. See and hear these magnificently-designed separates at your JVC dealer soon.

For details on all JVC Hi-Fi Equipment, write to JVC Advisory Service, P.O. Box 307, North Ryde, New South Wales 2113.

Top JA-S22 Bottom JA-S55 Top JT-V77 Bottom JA-S77

For pure Hi-Fi entertainment!

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the right choice

Top JT-V22
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*45 watts/channel, min. RMS, 8 ohms, from 20Hz-20kHz. with no more than 0.02% THD.

WT93/78

serious problems will appear on the transmitting side of the equipment.

The first tests carried out with high quality receivers in the USA show considerable differences in the performance of the various systems. For example, signal-to-noise ratios of 44dB, 47dB and 56dB have been quoted for the Belar, Magnavox and the Motorola systems, but intermodulation levels using 200Hz and 2.5kHz signals of amplitude ratio 4:1 were measured as 0.65% using the Belar system, 1.11% using Magnavox and 2.5% using the Motorola circuitry. Tests have also been carried out using economical and medium priced equipment.

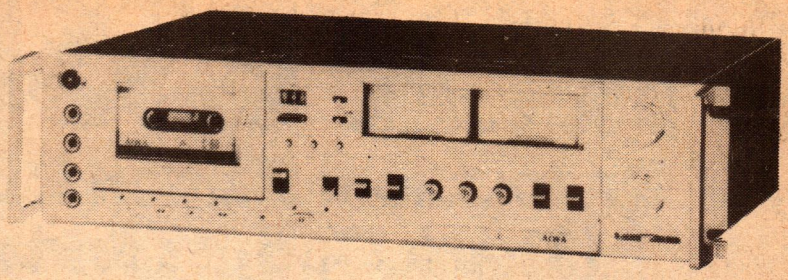
We must now just wait for further developments or possibly even for a decision that the market demand would not justify stereo transmissions on the lower frequency bands!

NATIONAL PANASONIC have moved to meet the demand for high quality stereo sound in cars, more comparable with what listeners are accustomed to in their homes.

The answer is summarised in the term "Car Compo" (short for "components") and comprise the following units:

- High quality stereo cassette deck CX-D1, with auto reverse;
- FM/stereo tuner CX-T1 with in-built interference absorption unit to combat ignition interference;
- Stereo preamplifier and control unit CX-P1, with front/rear fade provision and excellent performance characteristics;
- Stereo main amplifier CX-M1, offering a full 20W RMS per channel output.

Typically, the complete system will retail for about $790, plus the cost of speakers: either the National EAB-752N 2-way coaxial units or EAB-76IN dome capped types, both of which are capable of handling the available power. For information: Haco Distributing Agencies, 57-69 Anzac Parade, Kensington 2033.



The AIWA AD 6900

AIWA (AUSTRALIA) PTY LTD are more than just enthusiastic about their latest "AD 6900 3-head logic control stereo cassette deck with flat response tuning system". Seen as the culmination of AIWA's expertise in cassette deck production, the AD 6900 combines modern technology with a high degree of compactness, in a cabinet only 12cm high. Claimed frequency response is 20Hz to 20kHz, with double pointer meters to indicate peak and average (VU) recording levels. Of special interest is the bias adjustment provisions which allow the bias to be set precisely and quickly for the widest reponse from any available cassette.

For further information: AIWA (Australia) Pty Ltd, 14 Gertrude St, Arncliffe, NSW 2205. Tel (02) 597 2388.

THE GREATER UNION ORGANISATION PTY LTD have introduced a new sound system concept into drive-in theatres. Known as "Cine-Fi", the first Australian installation was at the Metro Drive-in in Chullora, Sydney, during August. In this system, the sound is fed to a transmitter, which, in turn, feeds a signal at any convenient frequency in the AM broadcast band into wiring serving the drive-in area. Patrons tune in the sound on their normal car radios or on portable radios, in most cases using better loudspeakers than are available from the normal drive-in pole system. The signal is not available outside the confines of the theatre, since the RF energy is conducted to each car position by cabling, rather than being radiated in space. For further information on Cine-Fi: Mr Trevor Moritz, GUO Theatre Supplies, 49 Market St, Sydney 2000. Tel (02) 2 0663.

M.R. ACOUSTICS, displaying commendable candour, have advised the withdrawal of two record releases, because they felt that the pressings currently available were not up to standard: "Binaural Demonstration Record" and "Stereo Demonstration

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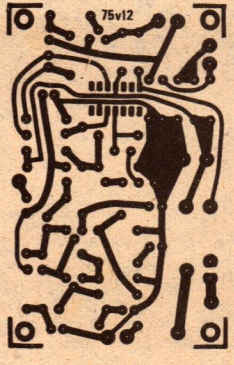

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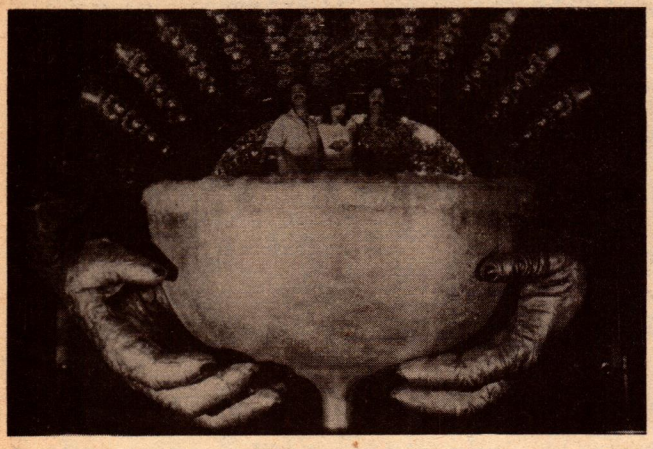
PROFESSIONAL

On location: Stanton is there where TGIF (Thank God, It's Friday) was filmed.



Go to the Club called *Osko's* in the Los Angeles Area. Revel in the sound around you, supplied to Osko's by Sound Unlimited Systems, Inc., a prime packager of Disco systems. They have supplied 90 systems to Stationary facilities and 60 to Mobile operations.

Sound Unlimited swears by Stanton's 500AL because they have used it for many years until Stanton came out with the 680 EL. Now they use this model exclusively in all of their installations, and endorse it without reservation.

Whether your usage includes recording, broadcasting, archives, Disco or home entertainment, your choice should be the overwhelming choice of the Professionals in every field . . . Stanton Cartridges.

P.S. "Thank God It's Friday" has turned out to be a dynamite film starring Disco Star, Donna Summer.

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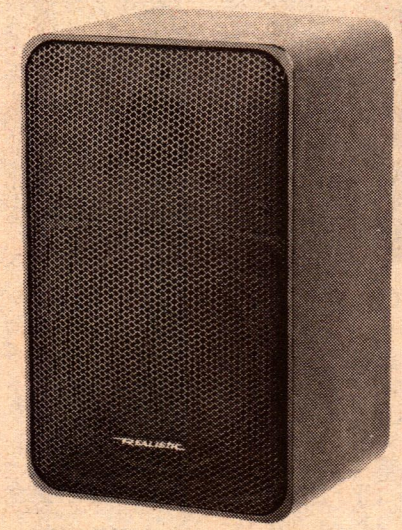
NSW Office: 100 Walker St, North Sydney 2060. Phone 922 4037
Victoria Office: 103 Pelham St, Carlton 3053. Phone 347 7620
Available at quality conscious Hi-Fi dealers throughout Australia!

Record". The SR12 test record is okay, however.

For photo and movie enthusiasts, M.R. Acoustics still have limited stocks of "Sounds For A Picture Evening" (4 records for $30) and "Music 'Round The World" (6 records for $35) both originating from "Popular Photography" magazine.

They especially recommend "The Guide To Understanding Music" which contains over 200 musical examples on 8 very long playing sides for $32. Recommended for children, adults, students and music teachers. The Qld Education Department have it listed as recommended for schools. (M.R. Acoustics, PO Box 110, Albion, Qld 4010).

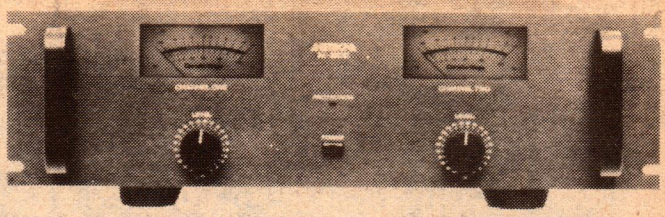
TANDY ELECTRONICS are offering a wide range of loudspeakers to audiophiles, as will be evident from their recent catalogue published with our October issue. However, they feel that their Minimus-7 should be especially interesting to those who have a space problem to solve. It is extremely



small at 179mm x 112mm x 109mm, yet it contains a separate woofer and soft-dome tweeter, to provide wide frequency response and a power handling capacity of up to 40W. In a diecast aluminium box with metal grille, it retails for $59.95. Enquire at any Tandy Store or at the Head Office, 280 Victoria Rd, Rydalmere, NSW.

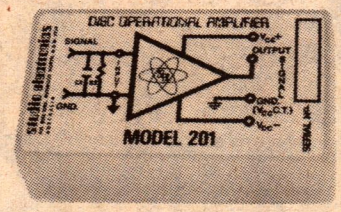
GRAHAM AUDIO PTY LTD have announced a line of "superb yet affordable electronics" to complement their famous Cerwin-Vega loudspeakers. The first of these, the METRON PR-1 preamplifier is a no-compromise unit, which "Audio" magazine credited with having one of the most accurate RIAA playback curves that they have ever measured. The "affordable" price is $A920.

A companion unit is the METRON



The Metron M-200 power amplifier. 125 + 125W, .02% distortion and $1020.

M-200 power amplifier which boasts 125W RMS per channel at a distortion level of 0.02%, and a price level of $A1020. But, for those who really want to invest, the METRON A-4000 offers 350W RMS per channel at the same low distortion figure, but at a price level of $A1980. For further details: Graham Audio Pty Ltd, 144 Brougham St, Kings Cross, NSW 2011. Tel (02) 357 1810.



STUDIO ELECTRONICS PTY LTD are marketing a whole range of audio modules, equally suitable for use in professional or domestic situations requiring readybuilt, easy to install components. Typical units in the range include:

201 RIAA AMPLIFIER: Intended to provide gain and compensation for all magnetic cartridges; input loading adjusted by external resistance and capacitance.

201 HA HEAD AMPLIFIER: For use with low output moving coil cartridges and ahead of the 201 RIAA module.

SEO-1 OPERATIONAL AMPLIFIER: Directly coupled and with differential input, this module can be used in a wide variety of applications such as mic preamp, general purpose preamp, mixing amp, booster amp, instrumentation amp, etc. Extremely wide bandwidth, minimal phase shift, etc. Application data available.

220 VOLTAGE CONTROLLED ATTENUATOR: A low noise, low distortion module for remote control of gain. Can be used singly or "ganged". Also useful in memory mixdown systems, industrial control, musical synthesis, etc.

Further details of these and other units can be obtained from Studio Electronics Pty Ltd, 3 Burwood Rd, Burwood, NSW 2134. Phone (02) 747 5686.

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Very few speakers will give you the bass that you can hear in real live organ recitals, rock concerts etc. This is because they often have little useful output below 50 Hz and virtually die at 40 Hz. But the music doesn't!

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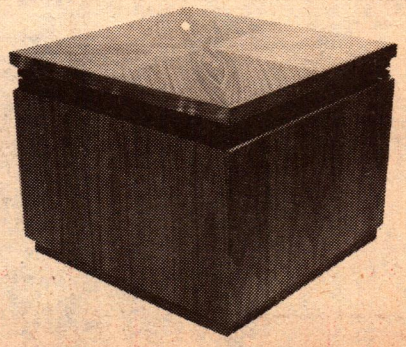
Used with the Janis Interphase 1 Electronic crossover/power amplifier unit, the results are really staggering! Add the Janis system to your present full-range speakers, or create a new superb speaker system using one Janis and a pair of small speakers with excellent treble and mid-range response.

And the Janis doesn't look like a wood-grained refridgerator in the lounge-room. The Janis is elegant, relatively small, and passes for a coffee table.

For details contact: M.R. Acoustics, PO Box 110, Albion, Brisbane 4010.



IT'S NOT WHAT IT DOES, BUT WHAT IT UNDOES.

It's no wonder your records are flat. Before they're pressed, about half of the music's dynamic range has been squeezed out.

The vice is the recording process. Live music's dynamic range can be more than 100dB, but the studio recorders have only 58dB of useable dynamic range capacity. So the engineer has to compress the signal, making the loud sounds quieter and quiet ones louder. And that's where the live gets squeezed out of it. Your conventional discs offer less than 50dB of dynamic range.

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The 3BX works equally well with budget-priced equipment and state-of-the-art systems. You won't need an audio engineer's ears to hear the remarkable improvement in the quality of your recorded music.

But we suggest you hear it for yourself. Take your favorite record or tape to your dbx dealer and ask for a demonstration. Once you hear the 3BX in action, you'll wonder how you ever listened to music without it.

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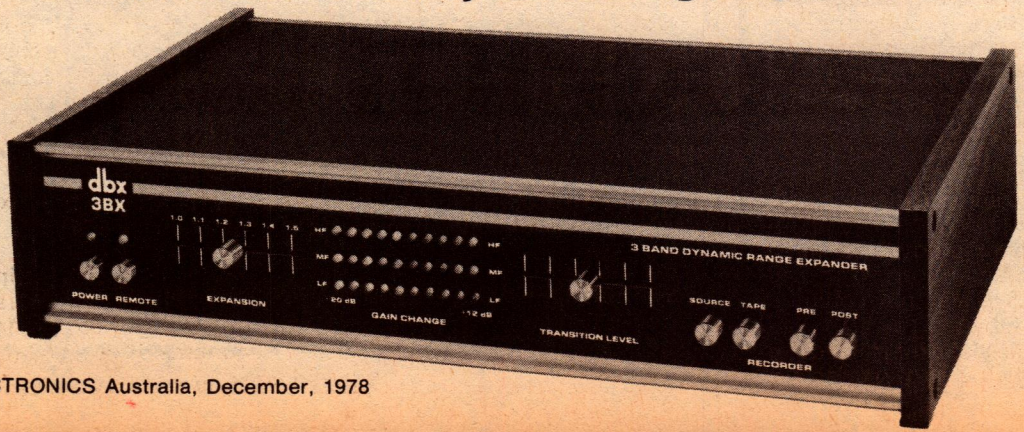
3BX three band dynamic range expander



Goldring G900SE Mk2 'moving magnet' cartridge

The G900/SE Mk 2 is at the top of the line of moving magnet cartridges manufactured by Goldring Products Ltd, of Suffolk, England. Weighing only 4 grams, it has a bi-radial stylus and recommended tracking force range of 0.75 to 1.5 grams.

Goldring does not use expensive packaging for its top-of-the-line cartridge, a point of which we approve. As shown in the photograph, it is supplied in a simple hexagonal plastic case which is packed in a white carton. Included with the cartridges are spare mounting screws, some gold plated pin connectors and a miniature screwdriver.

At only 4 grams, the G900SE must be one of the lightest cartridges made. It has a bi-radial stylus, 18 x 5 microns with the very low tip mass of 0.32 milligrams. It has standard 12.7mm mounting centres and the EIA colour coded output terminals. The stylus assembly is removeable by the user.

Inductance of the cartridge is 540 millihenries and DC resistance is 700 ohms. Output voltage at 5cm/sec is 4.5 millivolts.

Setting up this Goldring cartridge in a typical headshell is not a simple task. The irregularly shaped cartridge does not have a recognizable reference line, to enable it to be easily aligned. Also the screws are rather tricky to insert.

Once the initial cartridge sent for review was set up in our turntable, it became clear that the tracking performance was not all one would expect from a top-of-the-line model. So we terminated our tests and requested another sample.

When this arrived and was set up, it proved to have a much improved tracking performance. As always though, we found that the best tracking performance was obtained when the tracking force was set to the manufacturer's maximum recommended setting, in this case, 1.5 grams.

On the CBS STR110 test disc, it handled all but the most savage of the lateral 300Hz tracks flawlessly, but produced audible distortion on the +18dB track. On the W&G 25/2434 test disc, it handled the +16dB drum track with slight mistracking at 1.5 grams. And on the Shure "Audio Obstacle Course" a similar picture emerged — all the tracks were handled without problems except for the highest level of the "Sibilance" tracks.

Like a few other manufacturers, Goldring provide an individual frequency response plot of both channels of the cartridge. However, the usefulness of this document is prejudiced by the fact that the decibel scales on the plot are not designated.

Even so, we found the sample's curve too smooth for us to duplicate.

We tested the cartridge with the recommended load of 47k shunted by 180pF. The frequency response obtained was within ±2dB from 20Hz to 20kHz except for a peak of almost +6dB centred on 16kHz. Separation over the midrange was good at 30dB in one direction and 26dB in the other, figures which agree with the calibration certificate supplied with the cartridge. However, at the region of resonance (16kHz) the separation dropped to only —4dB.

Waveform on sinewaves was good in the midrange, but had the typical tendency to become a sawtooth in the treble region from about 6kHz to 12kHz.

Square wave response of the cartridge was poor — there is no other word for it. The square wave showed well-damped ringing, but a drastic overshoot peak of more than 40%. This seems to be far more than could be expected from the peak in the steady state response noted above, and indicated a transient response problem.

In fact, the problem manifested itself as accentuation of disc imperfections. Clicks and pops which might otherwise go unnoticed were quite loud.

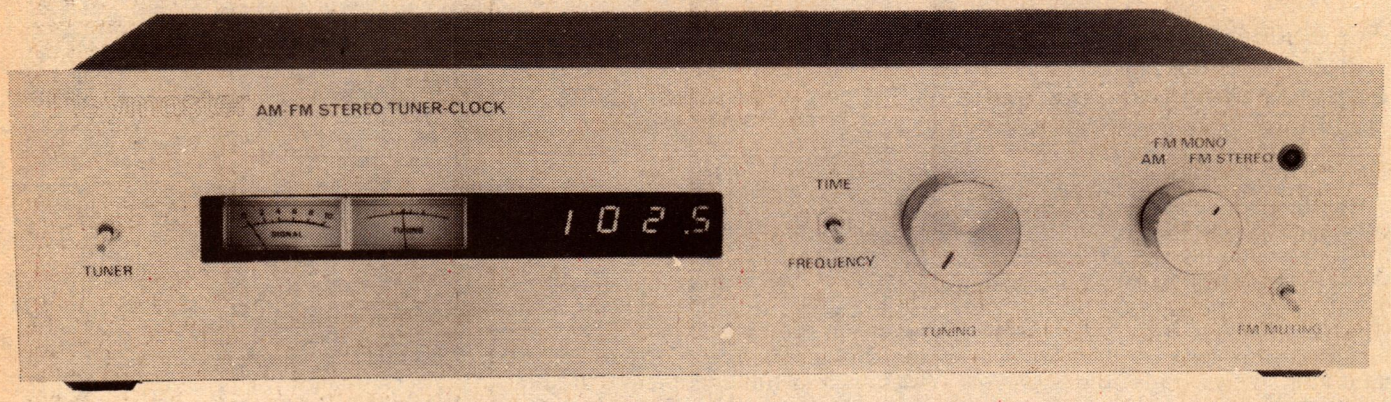
In other respects the sound quality was good, with perhaps some accentuation of the upper treble region.

Our summary cannot be enthusiastic. Perhaps we were unlucky to strike two samples which were unrepresentative, but at best it still suggests that Goldring have a quality control problem.

Recommended retail price, at the time of writing, was expected to be $135.00.

Further information on Goldring products can be obtained from the Australian distributors, Soundring Distributors Pty Ltd, 1/514 Miller Street, Cammeray, NSW 2062 (L.D.S.).

Playmaster AM-FM Stereo Tuner-Clock



second article gives the construction details

In this second article on the Playmaster AM-FM Tuner with digital readout and clock, we present the digital circuitry and the constructional details. The new tuner is already creating considerable interest amongst constructors, particularly with the recent announcement of additional FM broadcast licences.

by LEO SIMPSON

A summary of the performance of the new tuner is provided opposite. A survey of all the tuners and receivers we have reviewed over the past three years shows that the new Playmaster tuner has a very creditable performance, typical of many medium price range units. This fact, combined with the new digital frequency readout and clock features, makes the Playmaster tuner particularly good value at a projected price of around the $140 mark.

Refer now to the circuit of the Playmaster Tuner-Clock. This shows most of the connections made to the Wangine WT-7700 module but to save space, the module is shown as a block. The full circuit of the module was published and discussed last month.

Just three integrated circuits control all of the circuit functions to provide the frequency readout and 12-hour clock. The major IC is the AY-3-8112 which has been developed by General Instrument Corporation of the USA. This LSI chip contains a large amount of circuitry which we will describe in brief.

Basically, the AY-3-8112 circuitry can be divided into four separate sections: clock, frequency counter, decoder and time-base. The clock counter accepts one-second pulses from the timebase section and divides by 60 in the minutes counter and by 12 in the hours counter.

Three pins on the 8112 chip control the timesetting functions for the clock counter. Pins 15 (set Hours) and 16 (set Minutes) are connected to the time-setting push-buttons on the rear of the chassis. Pin 4 can be used to inhibit the time-setting switches to avoid accidentally shifting the time. However, since there is a one-second delay before the time-setting switches begin to advance the counter, and because the push-buttons are on the rear panel (away from curious little fingers) we have elected not to use the inhibit facility available at pin 4. Instead, it is connected to the positive supply for the chip, to permanently enable the switches. There is another inhibit facility built into the chip — the time must be displayed for the switches to be enabled. Pressing the time-setting buttons when frequency is displayed has no effect.

Compared with the clock counter, the frequency counter is more complicated. Like the clock counter, it has 3½ digits and is theoretically capable of displaying a maximum reading of 1999. But the frequency counter is unusual in that it is not set to zero at the beginning of a count sequence. It is said to be "offset", or preset. The "offset" is equal to the intermediate frequency of the AM or FM tuner section being measured.

When measuring the AM local oscillator, the 8112 frequency counter is preset to 1550, which is the appropriate offset for the 455kHz intermediate frequency. When the tuner module is set to receive say Sydney station 2SM on 1270kHz, the local oscillator is 1725kHz (or 1.725MHz). This frequency is fed to the counter, which counts up from 1550 to 1999, on through zero and up to 1270.

If that does not seem to quite add up, remember that the AM display increments in the 10kHz steps and reads the centre of the band (i.e., the station frequency) even if the tuner is up to 5kHz off centre.

Performance of prototype

FM SECTION

TUNING RANGE	87-108MHz
SENSITIVITY	4uV for 50dB Quieting (mono)
ULTIMATE SIGNAL- TO-NOISE RATIO	—64dB (unweighted) stereo —70dB (unweighted) mono
FREQUENCY RESPONSE	—4dB at 15kHz (see graph)
SEPARATION	—36dB in both directions
AUDIO OUTPUT	500mV RMS into 10k load with full modulation
HARMONIC DISTORTION	less than 1% in stereo; less than 0.5% in mono, with full modulation
19kHz RESIDUAL	—38dB
38kHz RESIDUAL	—58dB (includes higher harmonics).

AM SECTION

TUNING RANGE	520-1650kHz
FREQUENCY RESPONSE	30Hz to 3kHz at —3dB points —10dB at 9kHz
HARMONIC DISTORTION	less than 2% at 30% modulation

Similarly, when measuring the FM local oscillator, the 8112 frequency counter is preset to 1893, which is the appropriate offset for the 10.7MHz intermediate frequency. Thus, when receiving Sydney station 2MBS-FM (102.5MHz), the local oscillator is 113.2MHz. The frequency counter takes 10.7 off this latter figure in counting up to zero and then counts on to 1025.

The frequency counter is "latched" which means that while the counter is going through a count sequence, its last count value is being displayed. This avoids a flashing or blinking display.

Pins 1 and 2 are the AM and FM local oscillator frequency inputs, respectively. Pin 3 is a logic control which sets the frequency counter to accept either the FM or AM input, and sets the offset (1893 or 1550) accordingly. When pin 3 is high, the counter is set for FM. When low, it is set for AM.

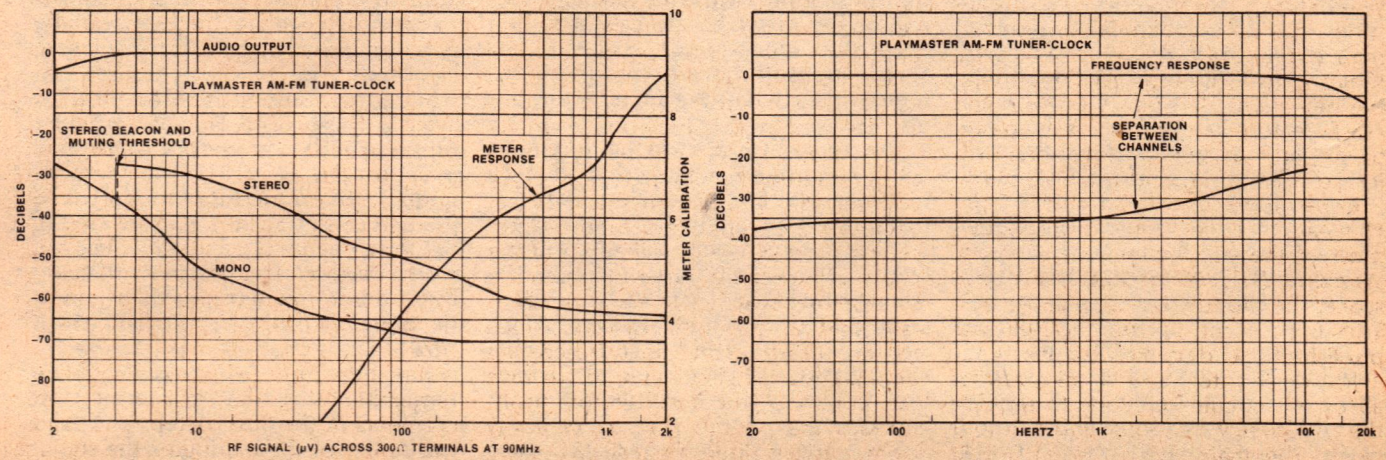
The decoder section of the 8112 interfaces the clock and frequency counters to the four LED seven-segment displays. The displays are multiplexed, which reduces the number of display output connections from the 8112 from 34 (4 x 8 = 32, + 2 for decimal points) to 12. Not only does the decoder provide the BCD-to-seven-segment conversion and multiplex function, it also adds in the decimal points, in the case of the clock and FM display.

Since the 8112 is a MOS device, it cannot drive the LED displays directly. Transistors Q1 to Q12 act as buffers for the digit and segment outputs.

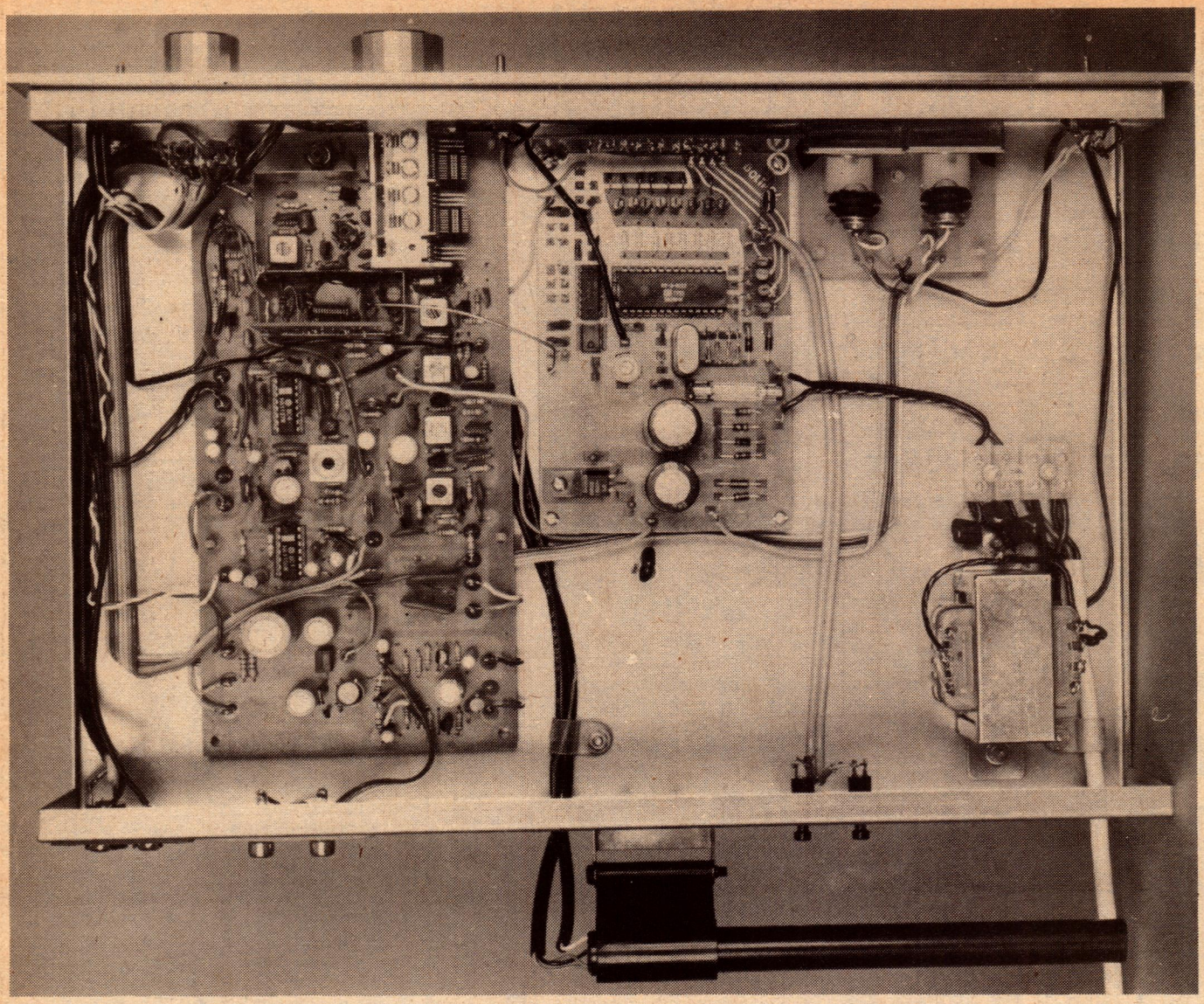
The diodes D1 to D4, connected to the digit pins 10 to 13 from pin 9, have nothing to do with the decoder function but provide the means for externally programming the FM offset. More will be said about these diodes at a later stage.

Diodes D5 and D6 ensure that digit driver transistors T1 to T4 turn off hard, when not turned on.

Connected to pins 7 and 8 of the 8112



These two graphs show that performance of the Playmaster tuner is typical of commercial tuners costing hundreds of dollars more.



This internal view shows the tuner with wiring complete. At right is the complete circuit diagram.

are a 2.304MHz crystal, capacitors and a bias resistor for a MOS inverter oscillator. This 2.304MHz oscillator is divided down to provide the frequency counter timebase, the multiplex display frequency and the one second pulses for the clock counter.

Pins 26 and 27 select time or frequency to be displayed. Actually, these pins are the toggle inputs to an RS flipflop, so rather than switch both pins were connected pin 26 to the OV line and control pin 27 with a resistor/zener diode network running from the tuner module supply.

When the tuner module is powered and S3 is closed, the zener diode conducts and feeds a positive voltage to pin 27. This selects frequency to be displayed. Removing the positive voltage, by opening S3 or turning the tuner module off, selects time to be displayed. The zener diode is included so that when the tuner module is turned off, the voltage at pin 27 falls to zero before the tuner regulated supply falls to half-voltage.

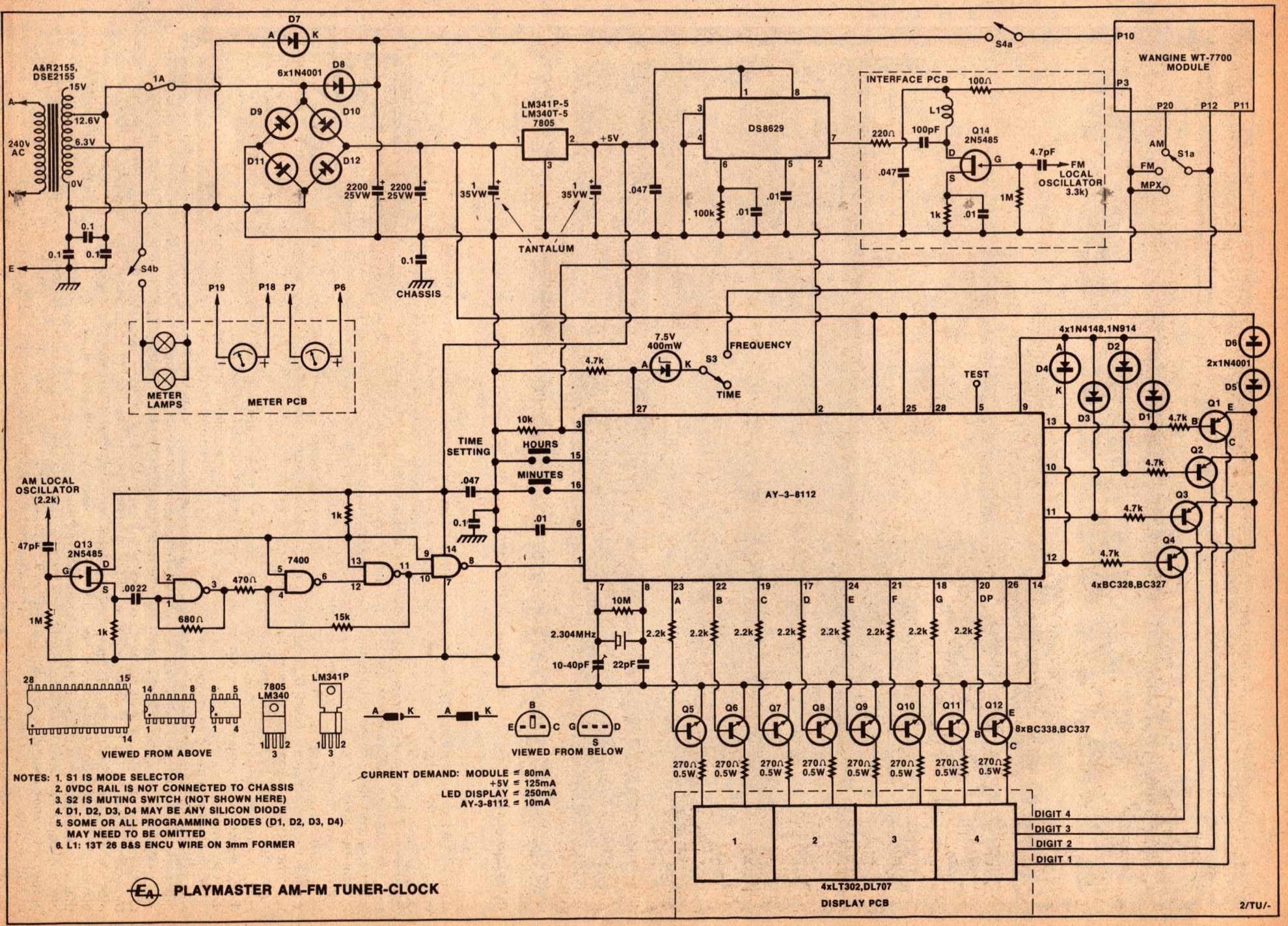
Without the zener diode, the local oscillator (AM or FM) stops before the pin 27 control voltage falls to zero. This means that the local oscillator input to pin 1 or 2 is interrupted before the display reverts to time. This results in a spurious display which is actually the AM or FM offset, as the case may be. Thus the zener diode provides an abrupt transition from frequency to time display, when the tuner is turned off.

The frequency input signals to pins 1 and 2 need to be suitably shaped and, in the case of FM, pre-scaled. The AM local oscillator ranges from 985kHz to 2.115MHz, which can easily be handled by the 8112 as far as frequency range is concerned. Fet Q13 buffers the output of the AM local oscillator and feeds it to a 7400 quad gate. The first and last gates act as input and output buffers, while the middle two are connected as a Schmitt trigger.

Since the FM local oscillator runs from 96.8 to 119MHz, it is way beyond the frequency capabilities of a MOS/LSI chip. The local oscillator frequency must first be divided by 100, and this is done by the DS 8629 prescaler IC. This is an economy prescaler developed by National Semiconductor Corporation. The DS8629 is an emitter-coupled logic device with a typical maximum frequency limit of 160MHz and an inbuilt ECL-to-TTL converter at its output. This makes it suitable for feeding the input of the 8112, which is also TTL compatible. FET Q14 provides buffering and isolation for the FM local oscillator.

The power supply employs a relatively large power transformer, considering that the device is but a tuner. However, adding up all the current demand (listed on the circuit) plus the drain of the meter lamps, gives a total which shows that the transformer is loaded to more than 50% of its rating. The transformer is a DSE 2155 or A&R 2155, with the 12V portion of the secondary feeding a modified bridge rectifier.

Diodes D9 to D12 are a conventional bridge rectifier providing just over 14



NOTES:
1. S1 IS MODE SELECTOR
2. 0VDC RAIL IS NOT CONNECTED TO CHASSIS
3. S2 IS MUTING SWITCH (NOT SHOWN HERE)
4. D1, D2, D3, D4 MAY BE ANY SILICON DIODE
5. SOME OR ALL PROGRAMMING DIODES (D1, D2, D3, D4) MAY NEED TO BE OMITTED
6. L1: 13T 26 B&S ENCU WIRE ON 3mm FORMER

CURRENT DEMAND: MODULE ≤ 80mA
+5V ≤ 125mA
LED DISPLAY ≤ 250mA
AY-3-8112 ≤ 10mA

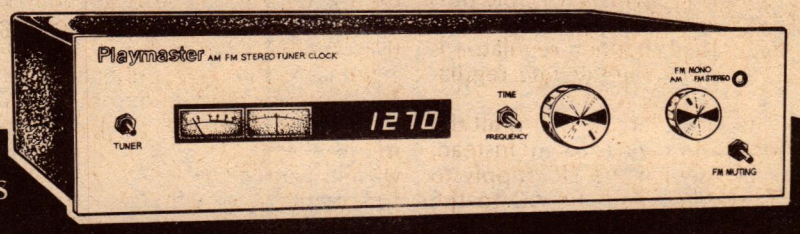
PLAYMASTER AM-FM TUNER-CLOCK

2/TU/-

Here it is - the perfect companion to the amazingly successful Playmaster Twin 25 and 40/40 Amplifiers....

PLAYMASTER AM/FM DIGITAL TUNER

Designed by Leo Simpson - See EA November/December 1978.



JUST LOOK AT THESE FEATURES AND SPECIFICATIONS:

* Full digital tuning on both AM and FM modes. Inbuilt digital clock - digital readout displays the time at the flick of a switch. Time remains on display even if tuner is switched off.
* Separate back-lit meters for signal strength and stereo tuning. Adjustable Ferrite rod antenna on back of chassis for AM reception. Switchable FM muting.
* Matches Playmaster Twin 25 and 40/40 amplifiers exactly. Same front panel size, colour and finish - same chassis dimensions. Can be used with virtually any stereo amplifier.
* Incredible performance - comparable with tuners priced hundreds of dollars higher. Specifications like - S/N ratio of -64dB (unweighted) stereo; IHF sensitivity of 2.2uV; stereo separation of -36dB in both directions and a harmonic distortion of less than 1% in stereo - it all adds up to a superb tuner.

Build it yourself from the Dick Smith Kit - and SAVE!

* Kit comes complete with factory built and aligned tuner module, all electronic parts, 3 mm thick bronze-anodized brushed aluminium front panel, matching knobs, chassis, all mounting hardware - even solder.
* Specially produced construction manual makes building this tuner e-a-s-y, even for the beginner. Explains every stage of construction from start to finish clearly, simply and concisely.
* Every kit contains a "Sorry Dick it doesn't work" repair coupon. In the unlikely event that you can't get your Playmaster tuner to work, you just send it in to our Service Department together with the coupon and a service fee - and we'll fix it for you. A Dick Smith exclusive service!
* 7-day nothing-to-lose trial offer. Purchase the Dick Smith Playmaster Tuner Kit K-3494, examine it for 7 days and if you feel that building it is beyond your capabilities, return the kit to us in the condition you received it and we'll refund your money in full. What could be fairer than that?
* Save $ hundreds! The only built-up Tuner we could find with features and performance anywhere near the Playmaster had a $950 price tag. Using the Dick Smith kit and a few hours of your own time you'll save hundreds of dollars.
* Terms are available to approved applicants on a minimum deposit of 10% and low monthly repayments. Terms can only be offered to personal shoppers only.

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volts DC to the 8112 chip and associated LED display circuitry. It also feeds a 5V regulator which powers the 8629 and 7400 IC's. The same 14V rail could be used to feed the regulator of the tuner module, but the superimposed 100Hz ripple is relatively high (approximately 700mV peak-peak).

As this ripple content could prejudice the signal-to-noise ratio of the tuner module, we have effectively provided a separate bridge rectifier with the addition of D7 and D8 and their associated 2200uF filter capacitor. This provides an unregulated supply of almost 15 volts DC with low ripple (less than 200 mV peak-peak). The higher input voltage to the tuner regulator is desirable to obtain better line regulation.

Since the clock circuitry runs all the time, there is no mains switch. Instead, S4 is used to switch the DC supply to the tuner module and the AC to the meter lamps. The AC winding to the PCB is fused (1 amp) to protect the unit in the case of a circuit malfunction.

Three capacitors strung between the transformer secondary and the chassis form a filter which reduces mains-borne interference. Other capacitors around the chassis prevent multiplex hash, generated by the display, from being radiated inside and outside the chassis and thus producing interference with AM and FM reception.

Layout is most important in the construction of this Playmaster tuner. The details of wiring shown in the various diagrams must be adhered to, otherwise there is the likelihood of hum and multiplex hash appearing in the outputs of the tuner.

Some of the interconnection details for the tuner module do not appear in the circuit featured here or in last month's issue. They are shown on the wiring diagrams.

A steel chassis, with the same overall dimensions as the Playmaster Twin 25 and 40/40 amplifiers (370 x 80 x 245mm), is used to house the tuner. A steel chassis is desirable to shield the ferrite rod antenna, for the AM section, from the hum field of the transformer. A steel cover for the chassis is not mandatory, a wooden sleeve may be used instead.

While the tuner module is supplied complete and fully aligned, a number of small modifications are required. As well, there are four other PCBs to assemble. Most of the clock/counter circuitry is mounted on the largest PCB.

Before assembling any of the PCBs, they should be carefully examined for faults in the copper patterns. These may take the form of breaks in the fine copper tracks or shorts between adjacent tracks. Find and repair any faults at this stage, when they are much easier to trace.

Take care, when making solder connections, to avoid damage to the PC pattern. Be careful to avoid making

PARTS LIST FOR THE PLAYMASTER TUNER

CHASSIS & HARDWARE

- 1 plated steel chassis, 370 x 80 x 245mm (W x H xD) with cover
- 1 front panel and red Perspex window
- 2 knobs to suit front panel
- 2 miniature SPST toggle switches
- 1 miniature DPST toggle switch
- 2 miniature momentary contact push-button switches
- 1 rotary 4-pole, 3-position switch
- 1 2-way RCA socket panel
- 1 2-way screw terminal panel
- 1 insulated 75 ohm coax socket
- 1 4-way insulated terminal block
- 7 Richco CBS-6N PCB supports
- 4 12.7mm brass spacers
- 2 grommets
- 2 cord clamps
- 4 rubber feet
- 2 solder lugs
- 1 3-pin mains plug and three-core mains cord
- 73cm of 10-conductor rainbow cable
- 30cm of figure-8 shielded cable
- 30cm of 300 ohm TV ribbon
- 30cm of 75 ohm coax cable
- 1 transformer, A&R 2 5, DSE 2155 with multi-tap 15V secondary winding
- 4 0.1uF metallised polyester capacitors
- 1 Wangine WT-7700 tuner module complete with adjustable rod antenna and stereo beacon LED
- Add: 3 x 100k/¼W resistors
- Remove: .0022uF capacitor for stereo blend (to be used on counter PCB)
- Plus: screws, nuts, washers, masking tape

COUNTER PCB

- 1 double-sided PCB with ground plane, 88 x 136mm, 78dt10a/g
- 2 fuse clips, Swann (McMurdo) FC1 part no 1397-01-18
- 1 1-amp 3AG fuse
- 1 2.304MHz crystal, AT-cut, 20pF parallel capacitance, HC6/U, wire leads
- 28-pin Molex connector strip for IC socket
- 20 PC pins or stakes
- 1 ⅛-inch Whitworth screw, ¼-inch long plus nut

SEMICONDUCTORS

- 1 AY-3-8112 clock-counter
- 1 DS8629N ECL prescaler
- 1 7400 quad 2-input gate
- 2 2N5485 or similar VHF FET
- 8 BC338/2N3904 NPN switching transistors
- 4 BC328/2N3905 PNP switching transistors
- 8 1N4001 silicon rectifier diodes
- 4 1N914, 1N4148 silicon signal diodes
- 1 7.5V 400mW zener diode
- 1 uA7805, LM340T-5 or LM341P-5 5V regulator

CAPACITORS

- 2 2200uF/25VW PC electrolytic
- 2 1uF/35VW tantalum electrolytic
- 1 0.1uF metallised polyester
- 2 0.047uF disc ceramic
- 1 0.01uF metallised polyester (associated with 8112 IC)
- 2 0.01uF ceramic (associated with 8629 IC)
- 1 0.0022uF metallised polyester (surplus from WT-7700 module)
- 1 47pF ceramic or polystyrene
- 1 22pF NPO ceramic
- 1 10-40pF ceramic trimmer (Stettner)

RESISTORS

(10% tolerance, ¼ or ½W, unless specified)

- 1 x 10M, 1 x 1M, 1 x 100k, 1 x 15k, 1 x 10k, 5 x 4.7k, 8 x 2.2k, 2 x 1k, 1 x 560 ohms, 1 x 470 ohms, 8 x 270 ohms/½W.

DISPLAY PCB

- 1 PCB 90 x 55mm, 78dt10b (not fibreglass)
- 4 seven-segment common-anode LED displays, LT-302, DL-707 or equivalent

INTERFACE PCB

- 1 PCB 45 x 30mm, 78dt10d
- 1 2N5485 or similar VHF FET
- 1 0.047uF disc ceramic
- 1 0.01uF disc ceramic
- 1 100pF ceramic
- 1 4.7pF ceramic
- 1 x 1M, 1 x 1k, 1 x 220 ohms, 1 x 100 ohms, all ¼W
- 3 PC pins or stakes
- L1 (see text)

METER PCB

- 1 PCB 69 x 49mm, 78dt10c
- 1 signal strength meter to suit
- 1 centre-tuning meter to suit
- 2 7.5V lamps
- 2 grommets to suit lamps
- 6 PC pins or stakes
- Plus: 16 gauge tinned copper wire
- NOTE: Capacitors and resistors with higher ratings may be used, if physically compatible. Other substitutions, unless mentioned in the text, are not recommended.

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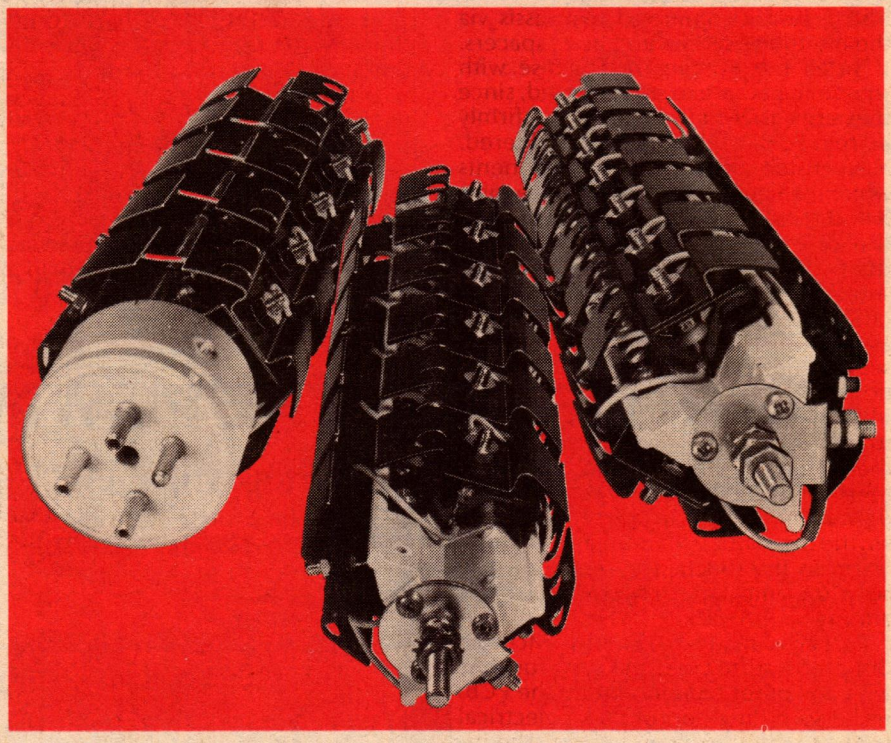
The extensive Philips range of ready-to-use rectifier assemblies facilitates the replacement of high voltage valve rectifiers with the much more reliable solid-state product. They are also ideal assemblies for use when building RF heater and transmitter power supplies.

A variety of base styles is available for easy plug-in replacement of valve rectifiers. On rare occasions it may be necessary to replace the valve socket.

Some popular types and their solid-state replacements are:—

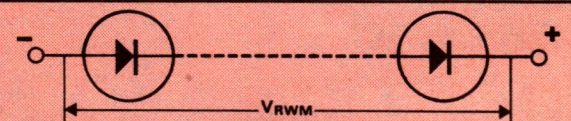
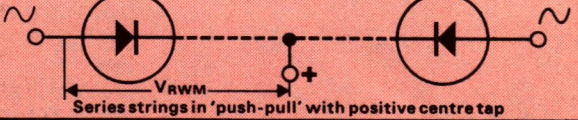
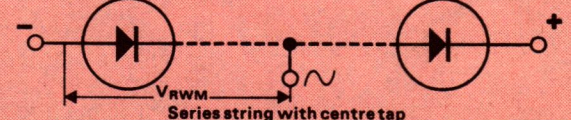
857B replace with OSS9410–30A
866A replace with OSS9110–3E
872A replace with OSS9110–12E

Basic data is presented in the table below. For further information contact Philips Electronic Components and Materials, or their distributors, for the shortform databook "POWER AT YOUR COMMAND", or the more detailed databook SC1A.



Philips Electronic Components and Materials,
P.O. Box 50, Lane Cove, N.S.W. 2066
Ph: 427 0888

BASIC DATA

Type No.	Average forward current $I_{F(AV)}$ max.	Crest working reverse voltage V_{RWM} max.	Configuration
OSS9110-3 to -30	3·5A (6A in oil)	3kV to 30kV	
OSS9210-3 to -30	5A (20A in oil)		
OSS9410-3 to -30	10A (30A in oil)		
OSB9110-4 to -30	7A (12A in oil)	2kV to 15kV	
OSB9210-4 to -30	10A (40A in oil)		
OSB9410-4 to -30	20A (60A in oil)		
OSM9110-4 to -30	3·5A (6A in oil)	2kV to 15kV	
OSM9210-4 to -30	5A (20A in oil)		
OSM9410-4 to -30	10A (30A in oil)		

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solder "bridges" or overheating the small pads until they lift. Use a low wattage soldering iron with a small chisel-shaped bit.

Assembly can begin with the counter PCB and its associated display PCB. The counter PCB measures 90 x 138mm and has a ground plane on the component side. The ground plane is not connected to the circuit of the counter board, but is connected to chassis via the mounting screws and brass spacers.

Install the PC pins first. Those with square shanks are to be preferred, since they are easier to insert and hold firmly in the PCB while they are soldered. Next install all the small components which lie flat on the board. We recommend a socket for the main IC made of Molex connector strip. The two sections are inserted (with the common shorting section outermost, so IC can be inserted) and soldered. Later, when assembly is complete, the IC can be inserted and the common shorting sections snapped off.

Bend the leads of the regulator so that it can be laid flat and secured to the PCB with screw and nut. This employs the copper pattern underneath the PCB as a heatsink. Even so, the regulator will normally run quite warm to the touch. The regulator may be a 0.5-amp type (LM341P-5.0) or 1-amp type (uA7805 or LM340T-5.0).

Fuseclips made by Swann (McMurdo) are used to hold the 3AG fuse. As with any other component on the PCB, make sure they do not make electrical contact with the ground plane. The insulated bodies of components may physically touch the ground plane, with no ill effects.

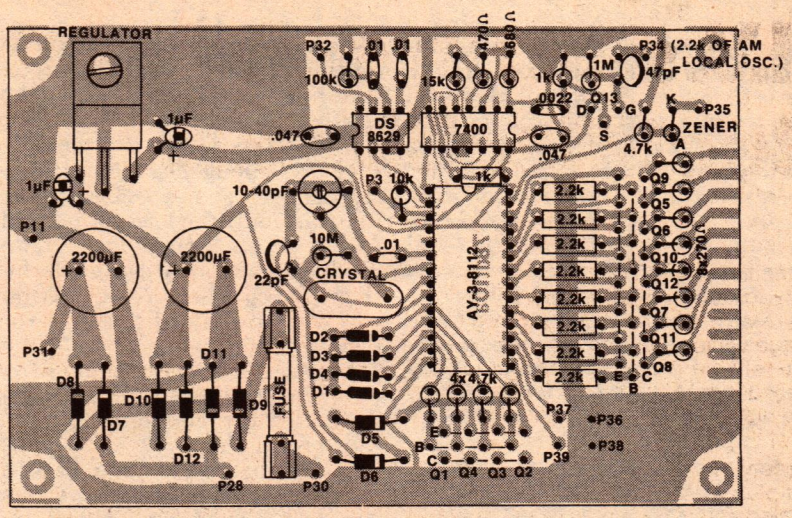
Now install the transistors and then the vertically mounted resistors, with their colour code bands running in the same direction. This makes it easier when checking the resistors on the PCB.

Transistor types specified for Q1 to Q12 have low saturation voltages. This is desirable in order to obtain consistent brightness from all segments and digits in the display. Substituting more common types such as BC108 and BC158 will result in reduced and less consistent illumination between digits and segments.

Note that the collector leads for transistors Q1 to Q4 must be soldered on both sides of the PCB.

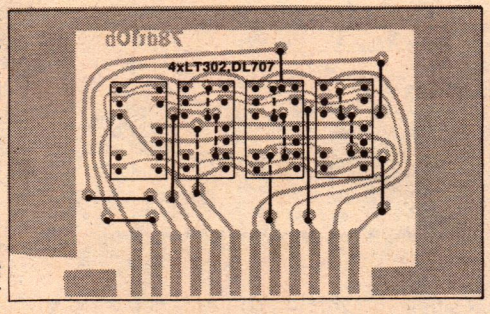
Resistors may be 5% or 10% tolerance and ¼W or ½W rating, except for the eight 270 ohm resistors which should be ½W rating.

Now mount the capacitors and diodes D1 to D4. Although we have specified 1N4148 or 1N914 for this function, virtually any silicon rectifier or signal diode will do. Install the diodes across the PC pins, as shown on the PCB diagram. At a later stage, it may be necessary to remove one or more of these diodes, to program the FM offset.



This is the component overlay diagram for the counter PCB.

Finally, the crystal and the two smaller ICs may be installed and soldered. Leave the 8112 chip in its conductive foam until the PCB is ready to install in the chassis. Having checked your work, the counter PCB can be laid aside and assembly of the display PCB can begin.



Install the links before mounting the LED displays.

Preferably, the display board should be of phenolic composition, rather than fibreglass which is semi-transparent. If a fibreglass board has been supplied it will be necessary to spray it black or mask it with black tape after assembly. This is to avoid having the meter lights shining through the PCB and reducing the effect of the LED display.

The display PCB 56 x 90mm and is attached to the counter PCB by soldering corresponding sections of the copper patterns together. A band of copper around the periphery of the display board is connected (when soldered) to the ground plane of the counter PCB — it must not be connected to the OV rail of the counter PCB. The PCB patterns of the two PCBs are arranged to avoid this possibility.

There are 15 links on the display PCB. All of these should be installed before the four displays are inserted. Take great care when soldering the displays to make sure that each connection is correctly made and that there are no solder bridges.

The display PCB is attached to the counter PCB by soldering the line of connector pads on both boards together. Alignment guides are provided near the lower edge of the display PCB. These should be aligned with the underside of the main PCB. Use a couple of stout tinned copper wires soldered to the copper patterns of both boards to hold them in alignment (and perpendicular to each other). Solder the connector patterns together and also the two large areas of copper on one edge of the PCBs.

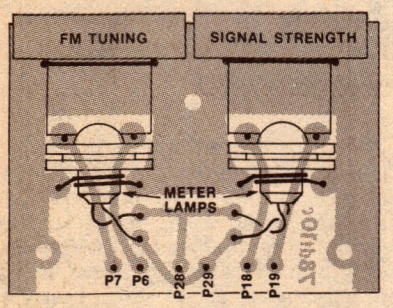
On the ground plane side, solder the abutting copper areas together at either edge and also the four conductors (to the display board) from transistors Q1 to Q4. That takes care of all connections between these two boards.

Fix a brass spacer to each corner of the counter assembly and it is ready for installation in the chassis.

The meter board is simple to assemble as it accommodates few components. It was devised to overcome the mechanical problems of mounting and illuminating the meters.

Insert and solder the six PC pins first. Bend down the solder lugs of the meters, insert in the board and solder. The centre-tuning meter should be on the right (looking from the front). Further location of the meters is provided by a loop of tinned copper wire pulled over the movement housing of each and soldered to the CPB. The lamps, which are of Asian manufacture, are supplied with long leads which can be cut to about 40mm,

stripped and tinned. They are positioned behind the translucent backs of the meters with the aid of stiffened 16G tinned copper which is wound once around the lamp body, soldered and then soldered to the PCB. The lamps should be about 25mm (measured from the centre-line) above the surface of the board. A grommet should be fitted to each lamp so that it shines only on its corresponding meter. Now solder the lamp leads to the PCB and fit three Richco supports. Place two 3mm (or ⅛-inch) washers over the centre support so that the PCB will be tilted up slightly when installed.



This is the meter PCB component overlay.

Use black electrical tape to mask off the lower portion of the meters. Now to the last PCB.

The interface PCB, coded 78dt10d and measuring 45 x 30mm, is designed to fit into the oscillator shield on the tuner module. The solid areas of the copper pattern, which are the OV line for Q14, are soldered to the oscillator shield, as shown in the photographs. Make sure that the PCB will actually fit in the manner described before assembly.

L1 is wound on a 3mm former (such as a screwdriver blade or ball-point pen refill) with 26 B&S enamelled copper wire. Wind on 13 turns, clean and tin the ends, slide off the former and solder into the PCB. Then mount the other parts. The .01uF and.047uF capacitors on this board should be ceramic disc types. Voltage rating is unimportant.

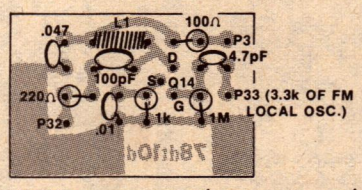
With the PCBs complete, attention can be turned to the chassis. First install the rubber feet, which may be adhesive types or attached with screw and nut. Next, install the terminal panel for the 300-ohm antenna, the 75 ohm coax socket, which should have an insulated body, and the time-setting switches.

The ferrite rod antenna must be disconnected from the tuner module before it can be installed. Before disconnecting it, make a note of where the three connections are made. Do they agree with the connections shown on our wiring diagram? If not, make a note of the difference. On our module, the connections were made on the underside of the module PCB.

If they are not supplied with the correct length, the sleeved wires from the ferrite rod should be shortened so that they are about 29cm long. Keep the sleeves as long as possible. The reason for shortening the leads is to avoid having an excess loop of leads under the module, which may cause interference to the FM circuitry. (Yes, even when the AM section is dead, the AM rod can pick up interference which is then induced into the FM circuitry.) Nor is it desirable for the AM antenna leads to lie under the counter PCB, so keep those leads short.

Install the rod on the back of the chassis with the two screws supplied. The rod should swing down and out from the chassis. Pass the leads through a grommet in the chassis and secure with a cord clamp. The same can be done with the mains cord. Now install the power transformer, insulated terminal block and solder lug for the earth wire of the mains cord.

The interface PCB can be attached to the tuner module now. First attach a short length (about 30mm) of insulated hookup wire to the FM local oscillator transistor's emitter or its associated 3.3k resistor, whichever happens to be the most accessible. This is a little tricky,



This PCB mounts on the tuner module.

since the shield around this part of the circuit makes access with a soldering iron difficult.

As a further guide in this exercise, look inside the FM local oscillator shield with the tuning shaft pointing towards you. The transistor's emitter, one end of the 3.3k resistor and a 10pF capacitor are soldered to a triangular pad. Just solder the lead to the common lead of one of these components. That done, you can solder the PCB to the shield, as described above.

A connection to the AM local oscillator must also be provided. This is made to the emitter of the transistor which is just outside the FM oscillator shield and close to P20 (the AM RF supply input). Make the connection to the transistor emitter or to the relevant 2.2k resistor. The connection can be made above or below the PCB (whichever is the easiest), but the hookup wire should be no more than about 50mm long.

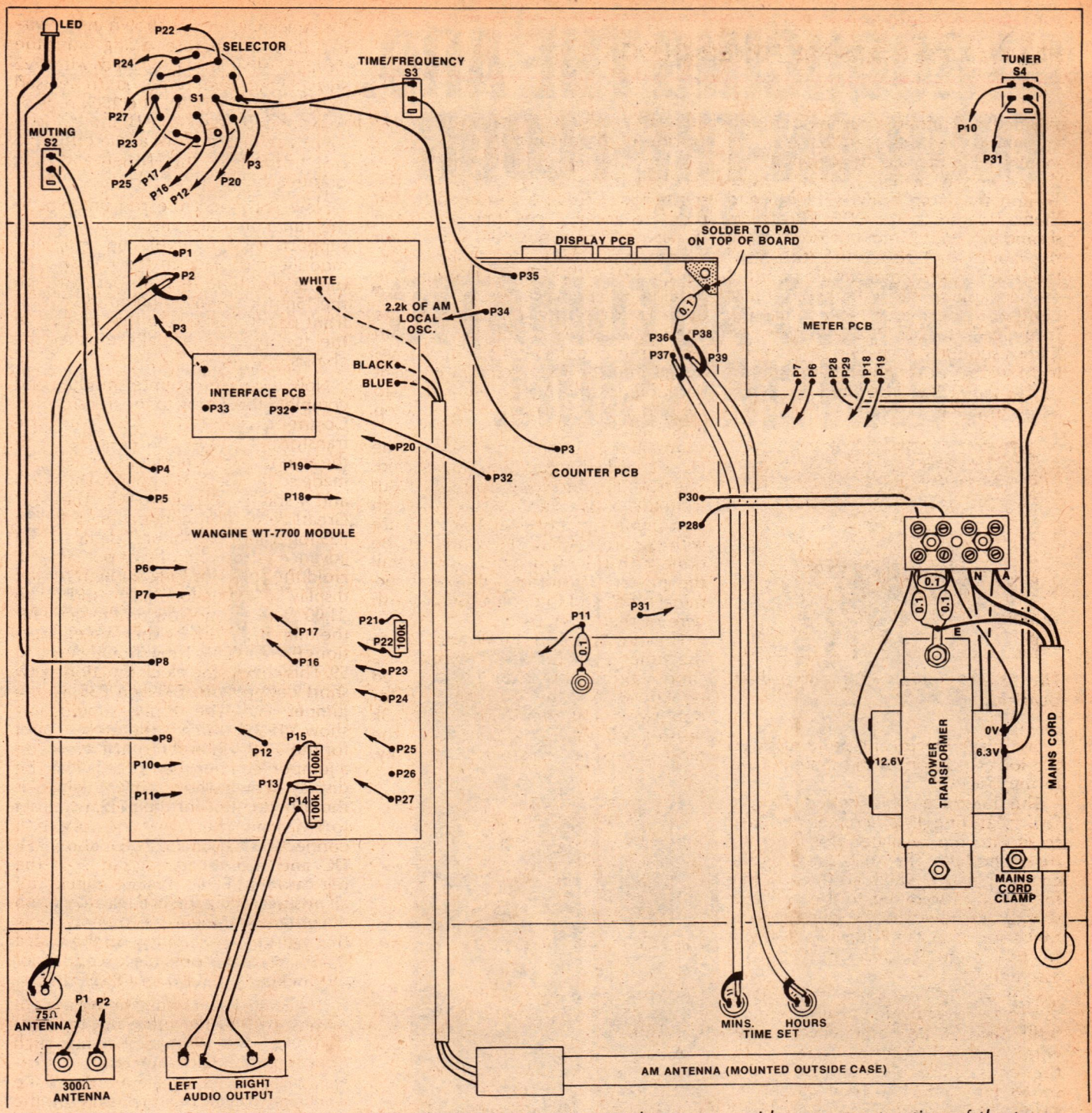
Three 100k resistors must be added to the tuner module, as shown in the wiring diagram. Before doing this, the .0022uF capacitor associated with P22 should have been removed (to be used on the counter PCB). The 100k resistor to be added between P21 and P22 is to slightly reduce the AM audio output to match that from the FM left and right outputs, P23 and P24.

Now reconnect the rod antenna to the tuner module, install four Richco supports (10mm high) and drop the module into place in the chassis. The tuning shaft and its bush pass through the 15mm clearance hole in the chassis front panel. Make sure that no part of the tuning gang actually touches the chassis.

Now install the counter module and complete the wiring to the transformer. Connect the 12.6V AC from the transformer and fit a three-pin plug to the mains cord. Check all connections made so far and apply power. Digits 2, 3 and 4 should display "0.00". They do? Great! Now short connections P38 and P39 together. The "hours" digits should advance at the rate of two per second. Hold the short for long enough for the display to count to "12.00" and on to "1.00" and so on. Now do the same for the minutes count by shorting connections P37 and P36. They should count to 59. This checks the clock function. Now short connections P31 and P35, with a jumper lead. The display should now show "1550" which is the preset count for the 8112, when set to AM. Now add a jumper lead between P3 and P35. The display should show "189.3" which is the preset count for the 8112, when set to FM. Now check that the voltage at connection P31 on the PCB is about 15V DC and the voltage at pin 2 of the regulator is 5VDC. If these checks are all positive, then you can breathe a sigh of contentment because you now know that most of the circuitry on the board is OK, with the possible exception of the inexpensive 7400 and 8629 chips.

If the checks described above are not all positive, do not jump out the window. The cause is probably minor, such as a poor solder connection. Unfortunately though, space in this issue does not allow the inclusion of the trouble-shooting notes. These will be featured next month. In the meantime, you can progress with the remaining assembly work but do not make further connections to the counter PCB.

A word of explanation of the numbering system for connections on the various PCBs is required. As supplied, the Wangine WT-7700 module is accompanied with a wiring diagram which numbers the various connections from P1 (one side of the FM antenna) to P27 (right channel input for the output buffer stage). We have arranged the numbering on the four additional PCBs to parallel this system and add further "P" numbers as required. That is why most of the connections on the counter are in the thirties.



Use this diagram, together with the circuit diagrams and PCB component layouts, to guide your construction of the tuner.

Wiring the chassis can now proceed. Start on the Selector, S1. Make up a harness using a 10-way strip of rainbow cable about 36cm long. Some idea of how to arrange the harness conductors can be gained from the chassis wiring diagram and accompanying photos.

Another harness using a six-way 36cm length of rainbow cable can be used to link module, counter assembly and meters. With that complete most of the remaining wiring can be done with the spare lengths of rainbow cable. The exceptions are the time setting switches and the FM aerial connections. Use "figure 8" shielded cable for the time-setting switches and 300 ohm ribbon and 75 ohm coax for the aerial connections.

Suspend the 300 ohm ribbon so that it is clear of the chassis and the cover (when installed).

The output connection, P32, from the interface PCB to the counter assembly is made with an 8cm length of stiffened 16-gauge tinned copper wire. Bend it as shown in the photographs.

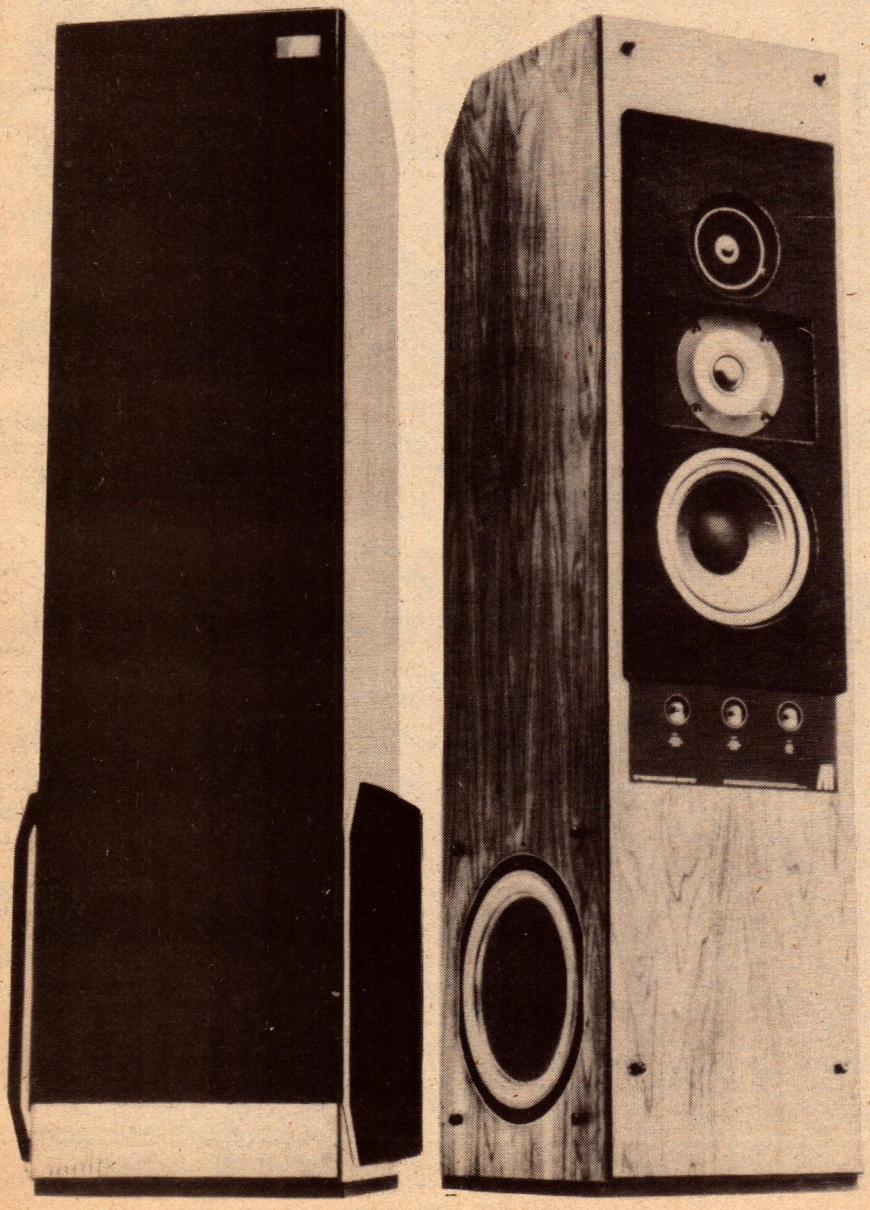
With all connections complete and checked, apply power. With the tuner switch set to off, the display should show the time at "0.00", as before. Set the time using the rear mounted switches. Now turn the tuner on and check that the tuning covers the frequency range shown in the specifications (or something close to it) for the AM and FM (with the time/frequency siwtch set to "frequency").

Now connect an aerial, an external stereo amplifier and loudspeakers and tune over the FM and AM bands. Check that the stereo beacon lights when a stereo station is received.

All that remains is to fit the dress front panel and knobs. The tinted Perspex window is attached to the front panel with masking tape attached so that it will not be visible. The front panel itself is held on by the retaining nuts for the switches.

(Continued on page 133)

INTRODUCING THE AR9. FOUR-ON-THE-FLOOR PLUS "ELECTRO-AUTOMATIC TRANSMISSION."



Bookshelf and mid-size speakers have been AR's act for 25 years.

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Refinements of proved AR engineering concepts abound throughout the system.

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Our ears tell us, and our test instruments confirm, that the new AR9 is nothing less than the most perfect speaker system possible today.

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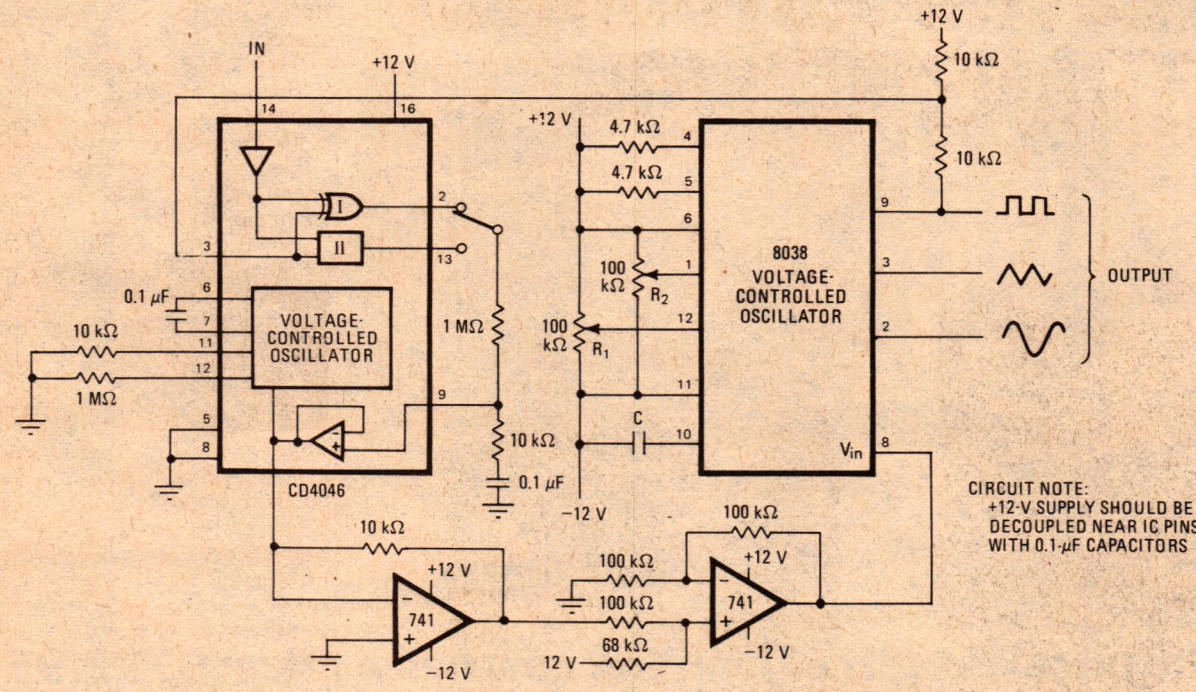
ar1/9

Circuit & Design Ideas

Conducted by Ian Pogson

Interesting circuit ideas and design notes selected from technical literature, reader contributions and staff jottings. As they have not necessarily been tested in our laboratory, responsibility cannot be accepted. Your contributions are welcome, and will be paid for if used.

Phase-locked generator converts and filters most inputs



Replacing the voltage-controlled oscillator in the RCA 4046 phase-locked loop with the Intersil 8038 waveform generator forms a circuit that produces sine, square, and triangular wave voltages capable of tracking almost any input signal. Besides performing its prime function of waveform conversion, the circuit serves as a high-Q filter. With a harmonic distortion of only 0.5%, it finds the fundamental frequency of any signal.

The performance of this circuit far exceeds that of a conventional filter, which always adds phase shift to the incoming signal. Also, traditional filtering methods are often of little use when the fundamental frequency must be recovered from an unpredictable input signal.

Connecting the 8038, which is itself a voltage-controlled oscillator, to the 4046 as shown in the figure does not affect the normal operation of the phase-locked loop. The only difference in the basic PLL circuit is that the 8038 generates sine, triangular, and square waves and drives the 4046 in place of the loop's internal VCO. The output waveshapes are unaffected by the harmonic distortion present on the input signal. Capacitor C sets the centre frequency of the 8038 (a value of .047uF gives a frequency in the audio range). The frequency capture range of the circuit, which is determined by the 4046, remains 1000 to 1. The generator's maximum operating frequency is about 700kHz.

To secure precise locking, the comparators in the 4046 should be driven by the square-wave output of the 8038. If the input waveform is a pulse, phase comparator I should be used. For unpredictable or high-noise signals, phase comparator II is more suitable.

Any phase difference between the square-wave output of the 8038 and the input signal is amplified by two 741 op-amps and then fed back to the VCO to increase or decrease its frequency, as the case may be. Although the internal VCO of the 4046 is not used, it must be enabled by grounding pin 5 of the device so that its voltage-follower will be active. If matched resistors are used at pins 4 and 5 of the 8038, the sine-wave output distortion can be reduced to 0.5%. Potentiometers R1 and R2 aid in minimising the distortion.

(By Peter Reintjes, in "Electronics".)

Curve tracer for NPN transistors

Q1, Q2 and Q3 form a staircase generator. Q1 operates as a free-running oscillator producing negative pulses across the base-emitter junction of Q2. Every time a negative pulse appears at the base, Q2 conducts, charging the .01uF capacitor for the pulse duration. Because this capacitor has no discharge path the charge and therefore the voltage across the capacitor iincreases in a staircase manner. When the charging voltage is high enough, Q3 fires and discharges the .01uF capacitor rapidly, thus ending the staircase cycle.

The staircase voltage waveform produces equal increments in base current from three to several hundred

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Advice for Parents Who Care

In your lifetime the possibility of owning or giving a computer—up to now—was unthinkable. A computer? That can teach? Remember? Display on its own screen? Play games? Complete with a standard typewriter keyboard? Unthinkable—up to now.

But now the Tomorrow Machine is not only thinkable but practical, affordable and available through every Tandy store and participating dealer. The TRS-80 personal computer system? For the kids? For Christmas?

TRS-80 manual, written by an educator, is 232 pages of instruction for a beginner.

TRS-80 system includes everything in this picture and, of course, the manual.

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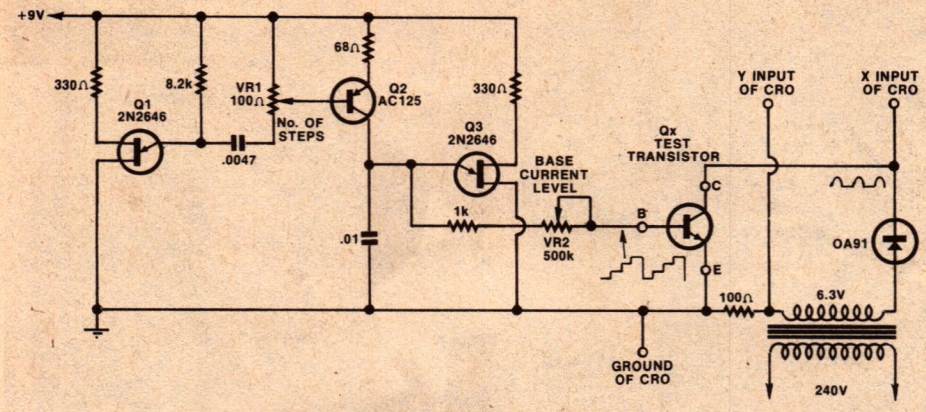


steps for the base-emitter junction of the test transistor Qx. The collector is energised by positive half sine wave pulses from the transformer and the germanium diode The circuit will display from three up to sixteen characteristic curves of Qx fairly clearly on a CRO screen. Collector to emitter voltage is displayed against a voltage proportional to collector current developed across the 100 ohm resistor. A typical display is shown.

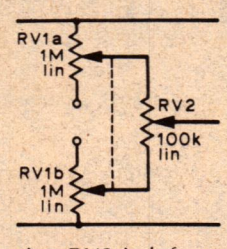
(By Mr P. Heggie, 2/2A Boonong Avenue, Seaford South, Victoria 3201.)

Editorial note: The overall idea seems to be a good one. However, it may be possible to improve results by synchronising Q1 of the staircase generator from the mains frequency. Perhaps this could be done by feeding a pulse from the transformer secondary via a small capacitor to the B2 lead of Q1.

Helical pot substitute provides fine adjustment

In these days of electronic tuning diodes and voltage-controlled oscillators etc, there is increasingly a need for potentiometers providing both a broad voltage span and yet capable of fine adjustment. This can be achieved with the modern multi-turn helical pot but these are quite costly components and not always readily available. An interesting alternative is suggested by O. Ormrod of Auckland, New Zealand and is shown in the diagram.

This arrangement achieves the "sensitivity" of a 10-turn helical pot for the price of a common two-gang potentiometer plus a conventional single unit. In practice RV2 is left at mid-travel while adjusting the coarse setting of RV1, and then carrying out final adjustment using RV2. For some applications RV1 could be "preset", so reducing the system to single knob operation. The system can of course be applied to any situation requiring accurate setting of a linear potentiometer, and the ratio between potentiometer values need not necessarily be 10:1, although this is a useful ratio.



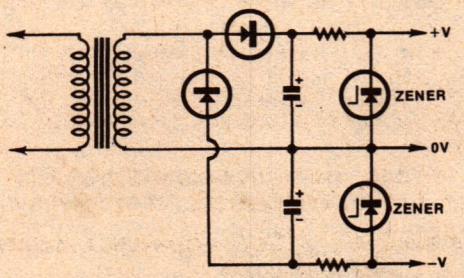
(From "Radio Communication".)

Simple bipolar supply for IC projects

There are times when most of us wish to make use of a transformer for some application but run into the problem that the secondary winding does not have a centre tap. I was faced with this problem when I wanted to make up a low current bipolar power supply for use with a project using ICs. I was able to solve the problem by making use of a half-wave voltage doubler circuit but adapting it to my requirements.

All that is involved is to create a centre tap for the DC output and zener regulate each half. The result is a positive and a negative DC supply equal to half the overall output voltage.

In my case, I used 15V zener diodes with series dropping resistors to suit my particular purpose. However, many readers may wish to change values to suit individual requirements. The rectifier diodes should be chosen to suit and in most cases type EM401 or similar would suffice. The electrolytic capacitors should also be selected to suit. The zener diode will naturally have the voltage rating as required and the wattage rating will have to be determined according to varying load needs. The series resistor will also be calculated to cover the needs of the particular case.



(By Mr A. Bayliss, Callemonda Park, C/- Post Office, Selby, Victoria 3159)

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An Electronic Seashell!

Here's a little novelty project which may well start a new craze. Hook it up to your hi-fi system, and it produces relaxing sounds very much like the surf on a beach. Use it to unwind after a hard day, or as a conversation starter!

by J. L. ELKHORNE
15 Myella Drive, Chigwell, Tasmania

Close your eyes and listen: the muted roar of the surf surrounds you, rises to a crescendo as a large wave crashes on the shore, then grows quiet again. Then another wave crashes and you can almost feel the spray shipped free — then, with the flick of a finger, all is silent.

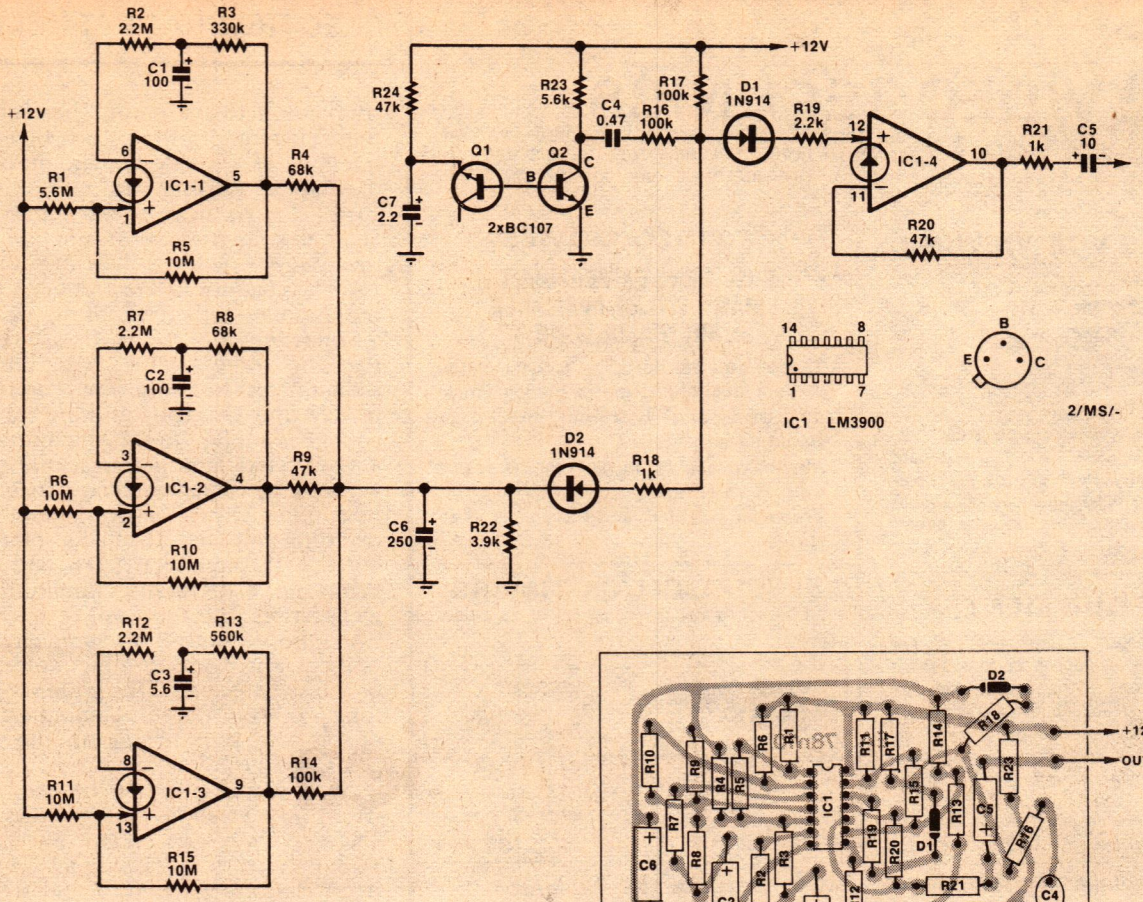
Perhaps you recall the sensation of putting a shell to your ear as a child, and seeming to hear the sound of the sea from whence it came. This novelty project creates the same effect, but can be fed through one's hi-fi system. When one grows tired of listening to music, whether it be Bach or Beethoven, the electronic voice of this little wavemaker can be quite relaxing. It's a wave-form generator with a vengeance!

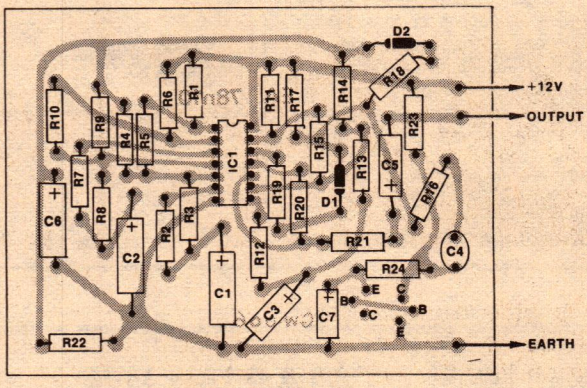
The "Electronic Seashell" might lay claim to being the world's smallest synthesizer. At the very least, it is one of the cheapest sound effects units that can be built. Only a handful of components lend themselves to imitating the surf. Heart of the project is an LM3900 quad current-differencing amplifier (CDA), which is so versatile that it can be used not only in linear circuits and for waveform generation, but in logic applications as well. However, we will confine ourselves to the application at hand.

If you haven't worked with CDAs before, this will be an inexpensive way to learn something about the little beasties. CDAs are not normal op-amps — they have their own lurks and perks — but can be treated like them. The prime differences are the ability to work from a single-ended supply quite nicely, reasonably performance, maximum and flexible use per package, and modest cost.

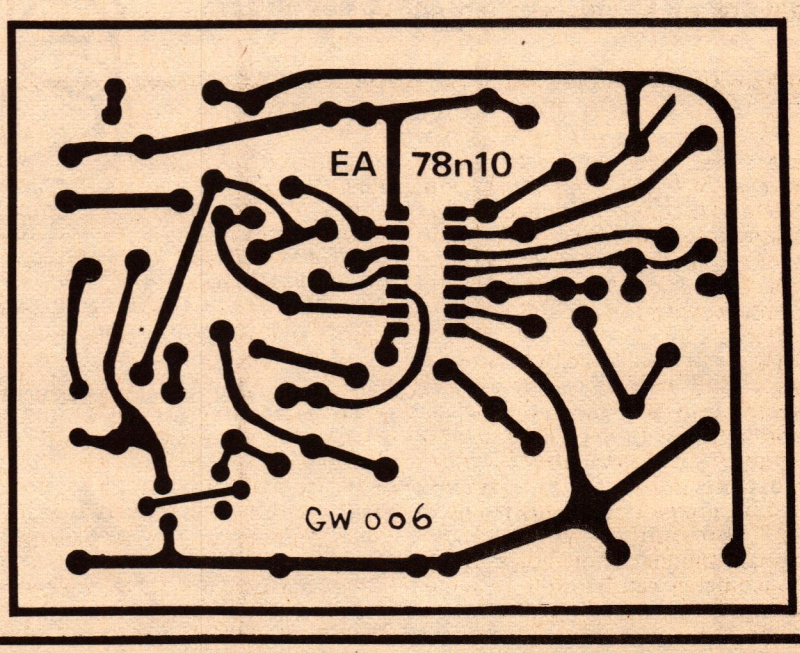
Axiomatic to the CDA are two fundamentals: (1) the differential-input CURRENT will be zero, and (2) in a closed-loop condition, the negative port input CURRENT will become equal to the positive, or reference port. These axioms refer to an ideal device: in practice, one finds offset variations, just as with standard op-amps, but which seldom get one into great strife. The first statement for the CDA is equivalent to the rule that the differential-input voltage of a standard op-amp is zero; however, in this case it is current difference that is paramount. Since the ports never shift in voltage, connecting them to a voltage source directly will be catastrophic. Series resistors become a necessity at all times.

In a basic CDA amplifier, the positive port input current is mirrored at the negative port. Added to that quantity will be an input bias current supplied from a source through a series input resistor. CDAs have a common-mode input current range which is comparable to the common-mode voltage range of standard op-amps. While open-loop gain is commonly not as high, there is more than ample for most purposes. Slew rate limitations may be more restrictive. One possible circuit arrangement should be noted: since the positive port current effectively appears as a shunt to the negative port, it is not mandatory and the port can be connected to circuit earth. Port currents in the nanoamps. region and the consequent megohm region





As you can see from the circuit above, the Seashell uses only a few low-cost parts. The PCB wiring diagram is shown at right, with the PCB pattern itself underneath and reproduced actual size for those who make their own boards.



resistors are typical.

Our "Electronic Seashell" utilises the capability of one LM3900 with very few outboard components. A glance at the diagram of the circuit will show that three of the separate current-differencing amplifiers are configured as asymmetrical astable multivibrators, with the fourt being used as an output amplifier. Transistor Q1 acts as a zener, producing white noise which is amplified by Q2 and fed to the voltage-controlled attenuator formed by D1, D2, R18 and R19.

If we consider IC1-1 as in the high output state, the reference current at the positive port will be $I = V+/R1 + E^0/R5$ with capacitor C1 charging through R3. When the voltage on C1 rises to the point where the current through R2 into the negative port equals the reference current, the output flips to the low condition. This, of course, lowers the reference current; C1 begins discharging its voltage and when the currents are again equal, the cycle repeats. The other two astables IC1-2 and IC1-3 operate in the same fashion.

CDAs have a facility for working on quite low voltages. The reverse-biased Q1 junction requires sufficient applied potential to achieve zener action, so a single supply was used to simplify the circuit. The prototype drew only 6.5mA with 12 volts applied. The cost of a mains-driven supply did not seem justified, so a battery holder was used.

The output voltage swings of the astables are well within one volt of

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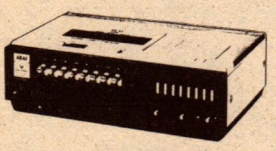

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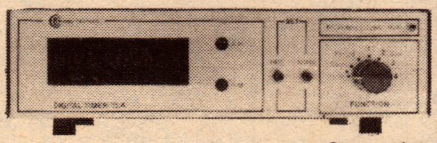

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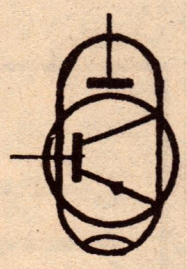

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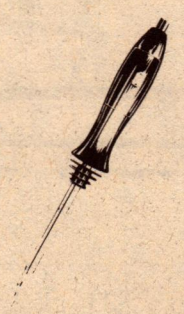

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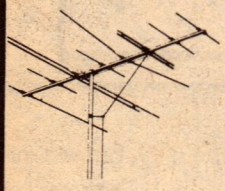

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ELECTRONIC SEASHELL

supply and virtual earth. The fact that their current thresholds are based on fractions of supplied voltage make the oscillation periods independent of supply variations. The Electronic Seashell will continue to function until the battery voltage falls below the zener voltage of Q1 — and even then, the astables still keep pulsing away.

Following the circuit flow, we see that the three astables sum through isolation resistors to a filter comprised of R22 and C6. The resulting random voltage is applied to D2 which serves as a controlled attenuator, padding the white noise signal in accordance with its conductivity. IC1-4 works as a non-inverting amplifier, receiving reference current through R17, D1 and R19. White noise of varying amplitudes, as well, passes into the positive port.

In the interests of simplicity, no attempt was made to effect coloration of the signal source. The wide range of tone controls on hi-fi amplifiers will enable the user to set up the most pleasing sound.

All of the circuitry of the Seashell is wired on a small PC board, measuring 100 by 76mm and coded 78n10. The PCB pattern is quite simple, and has been reproduced here actual size for those who may care to trace it and make their own board. The PCB wiring is shown in a separate diagram.

Housing the unit is not critical, A small metal utility box would be fine, with the PCB on spacers and say an RCA connector for the audio output.

So, build it up, turn it on — and you, too, can have the sound of the surf in your lounge room.

LIST OF PARTS

PC board, 78n10, 100 x 76mm
IC1 LM3900
Q1,2 BC107, BC547, etc
D12 1N914 or similar
R1 5.6M R2 2.2M R3 330k
R4 68k R5 10M R6 10M R7 2.2M
R8 68k R9 47k
R10 10M R11 10M R12 2.2M
R13 560k R14 100k R15 10M
R16 100k R17 100k R18 1k
R19 2.2k R20 47k R21 1k
R22 3.9k R23 5.6k R24 47k
CAPACITORS
C1,2 100uF 16VW electro
C3 5.6uF 16VW tantalum
C4 0.47uF LV polyester
C5 10uF 16VW electro
C6 250uF 16VW electro
C6 250uF 16VW electro
C7 2.2uF 16VW tantalum

Small utility case as desired; RCA or similar output connector; battery holder, etc; nuts and bolts.

Where to buy printed boards etc

A frequent request from readers concerns the availability of printed circuit boards for our projects. To a lesser degree they also enquire about chassis and etched panels.

Some readers imagine that we manufacture and distribute boards. Others appear to believe that these are available only from special sources. We do not manufacture or distribute any of these items, or any other components. But we are concerned that our readers should be able to buy these parts with no more difficulty than the other components used in a project. When a project is ready for publication we distribute drawings of printed boards, chassis, and front panels to a number of manufacturers who have requested this information.

These manufacturers are then in a position to supply these items to any distributor who requires them or, in some cases, direct to the public. On this basis you should be able to obtain these items from the same distributor who supplies your resistors, capacitors, transistors and other routine components. If he does not have them in stock he should have no difficulty obtaining them to order.

However, for the benefit of those readers who may have difficulty in obtaining these items, for one reason or another, we list below those manufacturers who are currently on our mailing list. If all else fails they should be able to either supply you direct, or advise which distributors are holding stocks.

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120 Briggs Street,
Welshpool. W.A. 6106.

James Phototronics,
522 Grange Road,
Fulham Gardens. S.A. 5024.

Mini Tech Manufacturing Co Ltd,
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Newmarket,
New Zealand.

Mr. R. P. Nederpelt,
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Bexley. N.S.W. 2207.

Statronics Pty Ltd,
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Brookvale. N.S.W. 2100.

ETCHED PANELS

Bespoke Metalwork,
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Brookvale. N.S.W. 2100.

James Phototronics,
522 Grange Road,
Fulham Gardens. S.A. 5024.

Jemal Products,
Unit 8,
120 Briggs Street,
Welshpool. W.A. 6106.

As a spin-off from the drawings we prepare for the trade, we can also supply copies for our readers (price $2.00). Those with access to metal working or etching facilities can take advantage of this to "roll their own".

However, beginners should be aware that this may not always be the most economical approach. To the cost of drawings must be added the cost of raw materials, wastage, etc, plus the disappointment which comes from a job which may fall short of professional standards.

As a general rule it costs very little more to buy the ready made product, saves a lot of time, and results in a much more satisfying end result.

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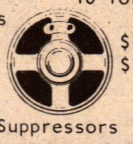

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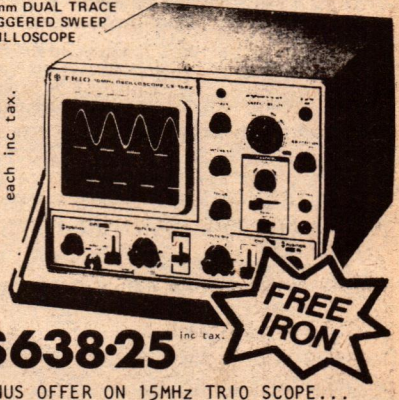

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Auto-electronics: some timely warnings

Modern cars are making increasing use of electronics in the fight to conserve fuel and cut pollution and, overall, they are doing a very good job. One problem, however, is that people not familiar with electronic devices can easily damage them by some of the well established service techniques popular in the past.

by J. de C. GRANDIN, A.S.E. (Aust.)*

The accompanying panel is typical of the warning plate or transfer to be found on most modern cars. While items (2) and (3) involve fairly self-evident reasons, the reasoning behind item (1) may not be immediately obvious. In fact, it was a question about this which prompted this article.

But before discussing this in detail, let us look at the rectifier system used with a modern alternator. (Figs. 1 and 2). Both "star" and "delta" stator windings are in use, but the same three-phase rectifying system is used for both.

Modern alternators, as used in a medium size family car, can charge at up to 50A. Commercial vehicle alternators can charge at even higher rates. Fast chargers can also deliver up to 50A.

Statement (1) in the warning panel prompts the logical question — why? What harm could possibly result from such a procedure? Since it would appear that the diodes will quite effectively isolate the battery from the alternator there seems to be no valid reason for the warning. More than that, there are plenty of people who have ignored it, without any adverse results.

On the other hand, car manufacturers are not prone to issue such warnings for the fun of it; they have their reasons, even if they are not immediately obvious.

The most serious risk appears to be that caused by reversed charger connections, particularly with a fast charger. Reversed charging for any length of time inevitably means a damaged battery but, in the past, that was the extent of the damage. The electro mechanical cut-out, as used on generators, effectively isolated the generator and associated circuitry.

This is not so with the alternator/diode system. With reverse voltage applied the diodes will be forwarded biased and will conduct. If a fast charger is being used the current flow could be heavy.

What happens from this point on is largely a matter of conjecture, and depends very much on what turns out to be the weakest link in the chain.

One possibility is that the current will be heavy enough to damage one or more of the diodes. This depends partly on the current capability of the charger, and partly on the rating of the diodes.

While it may be argued that the fast charger may not deliver any more current — about 50A — than the rectifier system may be required to deliver in the normal way, the situation is not exactly the same. A major difference is that, when charging, the total current is shared by the three rectifiers, so that the average current handled by each is considerably less.

With reverse DC applied, most of the current would flow through that rectifier (pair) which exhibited lowest forward voltage, resulting in considerable heat rise. Added to this is the fact that the alternator body, which acts as the diodes' heat sink, is not being cooled by its fan.

An open diode, particularly one on the chassis side of a pair, would probably be the worst possibility, since this could allow most of the charger voltage to be applied to the stator windings. The resultant current flow could be very heavy and the windings could be damaged.

Alternatively, if the diodes hold out it may be the charger that suffers, assuming that it is not protected in some way. On the other hand, if it is well enough protected to sense the short circuit in the first place, and perhaps trip itself off, then no serious damage may result.

The point is that it is impossible to know just what might happen. At best, the initial error — reversed charging — may become evident immediately. At worst, it may be allowed to continue for a lengthy period and initiate a series of catastrophic failures which could wreck the alternator as well as the battery.

WARNING

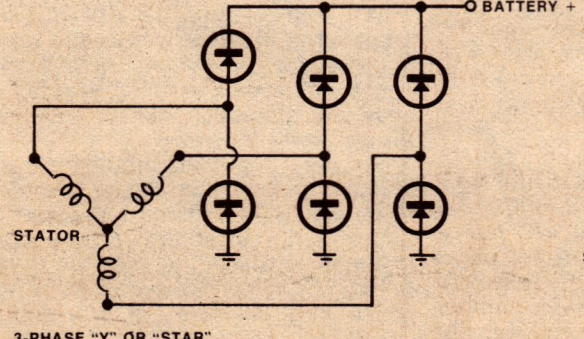
TO AVOID DAMAGE TO ALTERNATOR/REGULATOR

(1) DISCONNECT BATTERY BEFORE CHARGING OR ARC WELDING

(2) ALWAYS CONNECT POSITIVE LEADS TO POSITIVE TERMINALS

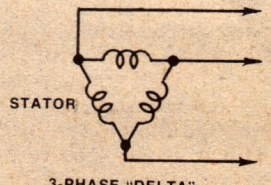
(3) NEVER SHORT CIRCUIT ANY TERMINALS

A typical warning label found in the engine compartment of most modern cars.



3-PHASE "Y" OR "STAR"

FIG. 1



3-PHASE "DELTA"

FIG. 2

Fig. 1. Winding and diode connections for a 3-phase "Y" or "star" alternator system as used in modern auto-electrical systems. Fig. 2 shows the alternative "delta" winding connections, which use the same diode connections.

*155 The Boulevarde, Strathfield, NSW, 2135.

The other most likely risk is that of high voltage spikes appearing on the mains, finding their way through the charger, and being applied to the diodes. A rather startling statement comes from the third edition of the General Electric SCR Manual (p249):

"In addition to random line disturbances, such as lightning, which have been recorded as high as 2600V on a 120V residential power line, transient voltages across SCR circuits may be generated by occurrences such as those described in figures 14.1 to 14.8."

These diagrams show how switching transients can occur. Most of them involve transformers feeding rectifier systems and indicate the generation of pulses when the primary circuit is opened or closed. Opening the switch at a moment of peak current, or closing it at a moment of peak voltage are the two most likely situations, but the presence of additional inductive devices can aggravate the problem.

The above suggests that voltage transients could find their way into the vehicle via a battery charger transformer connected to the mains. The coupling could be due to both the capacitance between primary and secondary transformer windings, as well as the normal transformer action.

While it might be argued that such spikes could not appear across the battery, this may be true only to a degree. Much would depend on amplitude of the spikes and the condition of the battery. If it was completely discharged and/or faulty it may not hold down high amplitude spikes.

Obviously, if such spikes caused a diode breakdown, the alternator system would not only be put out of action, but might be more severely damaged before the user was aware of any problem.

And, still on the theme of statement (1) on the warning plate, what about the small household charger, working at a few amps, which is sometimes used in an emergency to recharge a battery overnight? Does its use call for the same precaution?

Perhaps not, or at least not to the same extent. Reversed connections will still damage the battery, but is more likely to damage the charger than the diodes or alternator. The question of spikes still remains however, and would seem to be just as valid for a small charger as a large one.

All things considered, there seem to be enough reasons to heed the warning, just to be on the safe side.

So much for the superficially puzzling statement on the warning plate. While on the subject of batteries and electrical systems, there are a number of other points worth discussing, but which are often overlooked.

Whenever a battery needs charging, it is logical to ask why. If the battery is nearing the end of its life, or if some electrical circuit has been left switched

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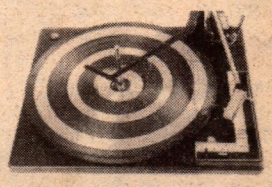

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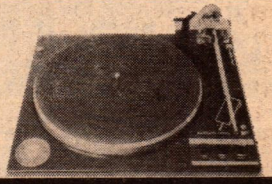

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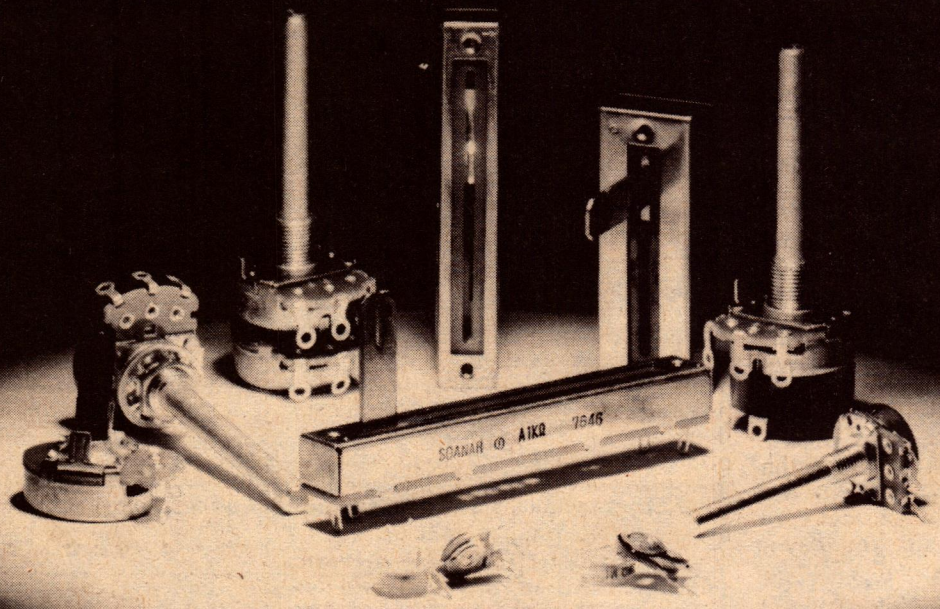

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on, then the remedies are obvious.

On the other hand, there is always the possibility that a circuit fault has flattened the battery. If so, it is likely that some damage will already have occurred, and there is no point in possibly aggravating this by either fitting a new battery or trying to charge the old one in circuit. The right thing to do is check for such a condition and, if it is found, correct it first.

Another thing to watch for is a battery that has been charged the wrong way round, ie, disconnected from the car wiring, charged in reverse by mistake, then reconnected. A battery so treated may not have much future, but it can store enough energy to do a lot of damage to an alternator system, or a polarised device, such as a radio.

Other polarity conscious devices include transistor ignition systems, transistorised fuel pumps, electronic fuel injection systems, "lean burn" systems, etc.

As well as damaging any of these electronic devices, there is also the chance that, when they fail, they can overheat their associated wiring. The author has seen the wiring behind the instrument panel turned into a fused mass of plastic and wire because of such a fault.

A simple way to check for such faults is to use a small trouble lamp (say 12W), such as many people carry for roadside emergencies. First, make sure the lamp is working by connecting it across the fully charged battery. Then connect the chassis lead of the vehicle to the battery. If the vehicle uses a negative chassis system (as most do these days), then this will go to the negative battery terminal.

Make sure all doors are closed and all electrical circuits switched off. Then connect the trouble lamp between the positive terminal of the battery and the active lead of the vehicle. (Fig. 3)

If the lamp lights, then a fault condition exists. Either the battery has been reverse charged, or there is an actual fault in the vehicle. Reversing the battery connections will indicate the first trouble, by the lamp failing to light. If it still lights then a wiring or component fault is indicated, and must be found.

If the lamp does not light, but it is subsequently discovered that certain circuits do not work, due to fuse or fusible link failures, then these should be restored and the lamp test repeated.

A couple of other precautions worth noting are taken from current service manuals. One, under the heading, "Battery Connections" states:

"The battery must never be disconnected while the engine is running or damage may occur to the rectifier and/or control box semiconductor devices. For this reason the practice of using a slave battery to start the engine and subsequently reconnecting the original battery while the engine is running must not be attempted.

"It is likewise inadvisable to break or make any other connections in the alternator circuit while the engine is running."

And from a different manual:

"Servicing Precautions. Correct battery polarity is imperitive. The alternator must not be operated with the battery cables disconnected.

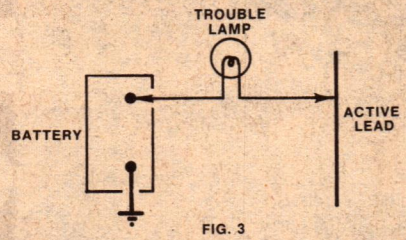

FIG. 3

An ordinary trouble lamp can be used to test wiring for possible short circuits before connecting the battery.

"When starting with the aid of a battery booster do not disconnect vehicle battery terminals.

"Battery leads should be disconnected before using a fast battery charger. Before carrying out electric welding, remove the battery leads and disconnect the alternator 'FLD'-'AUX' connecting plug."

Recently, the attention of the author was drawn to damage caused to transistor ignition systems by mechanics making compression tests, without a helper to turn the key to the start position. A popular practice is to use a press-button jumper lead to activate the relay and starter solenoid, with the HT lead withdrawn from the distributor to prevent the engine from starting.

Many modern cars use a lower voltage ignition coil operating from the 12V supply through a ballast resistor. This resistor is shorted out for the starting sequence to assist starting. In some cases the starter solenoid performs this shorting function, as well as its primary role. This was the set-up with the cars in question.

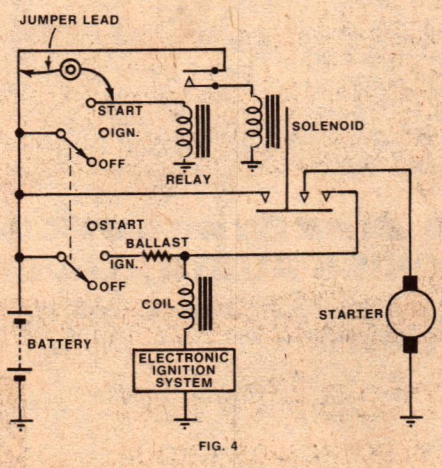

FIG. 4

By-passing the ignition key can allow spikes from the starter motor to damage an electronic ignition system.

However, when the press-button on the jumper lead is released the solenoid can break the circuit from the battery a brief instant before the ballast resistor contacts open. In these circumstances the collapsing magnetic field from the starter can send a pulse back to the ignition system and cause damage. With the ignition key turned off, there is no battery across this part of the circuit to dampen the pulse.

For this reason it is safer to activate the solenoid in the normal way, via the ignition switch. The ignition system can be de-activated by removing the HT lead from the distributor but it should be connected to chassis. Simply disconnecting the HT lead is not good practice, since the coil can generate very high voltages which may damage its internal insulation.

Summing up; more and more semiconductor devices are finding their way into automotive electrical systems and are making a significant contribution to improved economy, reduced pollution, and better overall performance. Under normal working conditions they can be very reliable — but they need to be understood and treated with proper care by those who service the vehicles.

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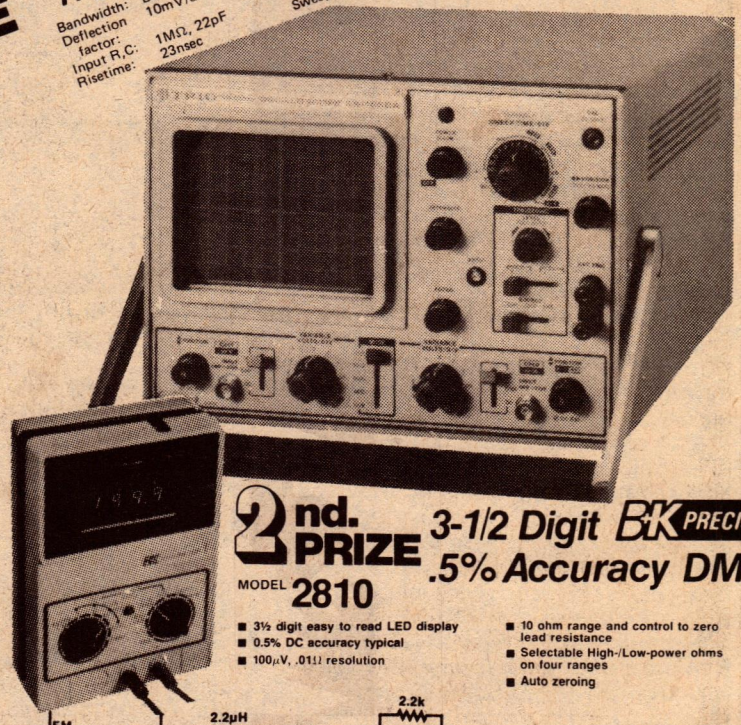

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In the November issue we published the circuit of the tuner module which includes the HA1137 Quadrature F.M. Detector — we've reproduced that part of the circuit alongside.

The contest is in 3 parts:

1. Describe the function of the HA1137 and how it works — reasonably briefly, but thoroughly.
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Entries should preferably be typed and double spaced. They can only be returned if an envelope and sufficient postage are included. Electronics Australia will have exclusive publication rights to any entry subject to our normal contribution rates and conditions.

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This last contest will make an excellent holiday project as well as giving you an opportunity to brush up your circuit knowledge. Accordingly, the closing date has been put back to Monday, February 5th.

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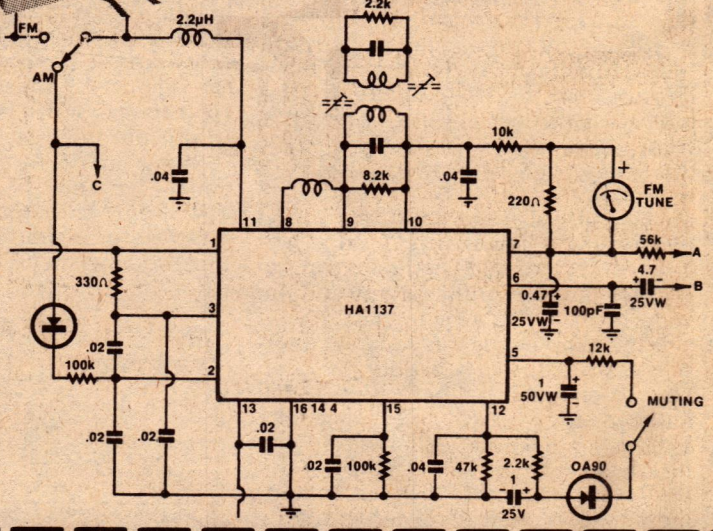

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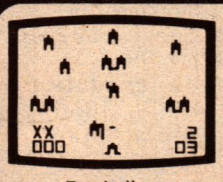

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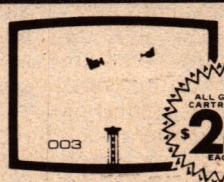

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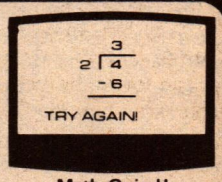
Maze



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Audio impedance meter

Part 1

The instrument described here can be used to measure the value of any AC impedance in the range of 1 ohm to 10 megohms, whether the impedance be inductive, capacitive, resistive, or any combination of these, and in addition will perform the functions of an RLC bridge. In conjunction with a signal generator, it can be used to plot the impedance versus frequency characteristics of loudspeakers and similar audio devices, and find the resonant frequency of tuned circuits within its frequency range.

by RONALD SALTER

12 Ayr St, Macleod 3085.

Over some years, the writer has had the need to measure the impedance of a variety of circuits and devices, ranging from normal inductance and capacitance measurements, to inductive signalling loops, and the impedance between earthed electrodes.

The method used, originally due to Terman[1], is shown in Fig. 1. The unknown impedance Z is connected in series with a calibrated variable resistor R — e.g. a resistance decade box — across an AC voltage source. The resistor is varied until the respective voltage drops across the resistor and impedance, as measured with a high-impedance voltmeter, are equal. Since the current is the same in both R and Z, it follows that the value of the impedance, in ohms, is equal to the value of the resistor, and this can be read directly from the decade dials.

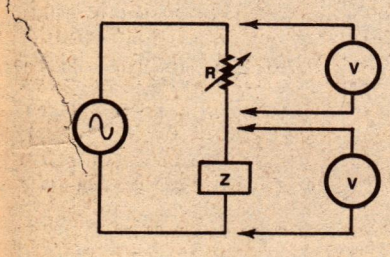


FIG. 1

It is easy to set up, but the need to take a number of voltage measurements in succession is inconvenient, and the accuracy is affected by any change in the frequency or voltage of the AC supply, particularly if it occurs between successive readings.

Casting around for ways to improve the method, the writer arrived at the circuit shown in Fig. 2. AC voltages appearing across R and Z respectively, are rectified by diodes D1 and D2, filtered by capacitors C1 and C2, and a DC null detector D — either a sensitive centre-zero galvanometer, or a DC oscilloscope — is connected between points A and B, which are at the same polarity. If the AC voltages across R and Z are equal, the DC voltages across C1 and C2 will also be equal, and the null detector shows zero.

In operation, the resistor is simply altered until the detector shows zero, and the impedance value is read from the resistor dials. The method is quick, and is immune to source voltage fluctuations, although the frequency must be accurately known, and stable.

This method, using a crystal-controlled oscillator with a low-distortion sine wave output, low-leakage matched diodes, low-leakage capacitors, a mirror galvanometer and precision resistance decade box, has been used by the writer to make impedance measurements to an accuracy approaching 0.01%, which is much higher than is used or needed for general electronic work. This method can be used to calibrate capacitors or inductors against standard resistors.

There is a big difference, however, between making one-off measurements in a laboratory, and designing an instrument for general purpose work. To cover, for example, an impedance range of 1 ohm to 10 megohms would require a 6-decade variable resistance using 60 close tolerance resistors and six 10-position switches.

Other disadvantages were revealed on further examination, causing the writer much head scratching. The final arrangement arrived at looks rather like an AC bridge circuit and is shown in Fig. 3.

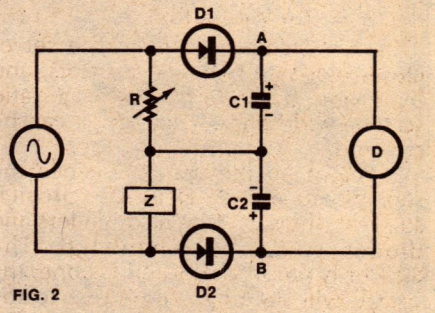


FIG. 2

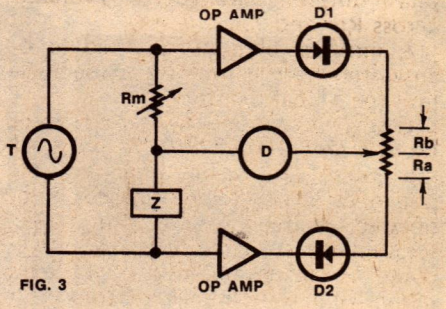


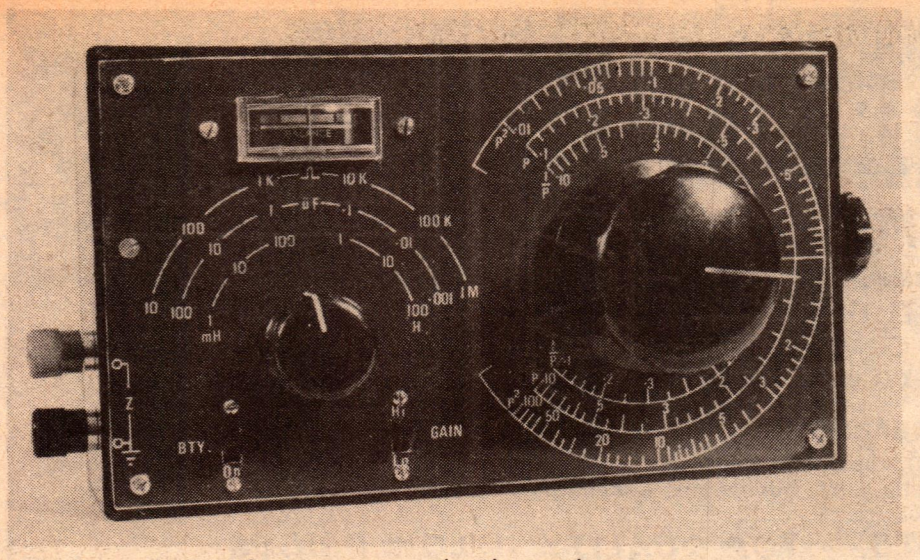
FIG. 3

A transformer, T, supplies AC voltage to a resistor Rm and unknown impedance Z, in series. The voltage drops across Rm and Z are fed to two ICs which, in conjunction with diodes, serve both as buffer amplifiers and linear rectifiers.

Note that the rectifier outputs are not at the same potential at balance, as in Fig. 2, because the polarity of the lower diode is reversed. This allows the connection of a potentiometer P, across these outputs, to form a ratio arm as in a normal bridge circuit[2]. A DC null detector is then connected between the potentiometer moving arm, and the junction of Rm and Z.

A null will occur when:

$$Z / Rm = Ra / Rb$$



A low-cost plastic utility case was used to house the prototype.

where Ra and Rb are the two arms of potentiometer P.

So the impedance can then be expressed as:

$$Z = Rm \times Ra / Rb$$

By now replacing Rm with a set of close-tolerance switched resistors, and by giving the potentiometer a ratio scale, a wide impedance range can be covered.

It might be thought that, since the similarity to an ordinary bridge circuit is so great, the operational amplifiers and diodes could be eliminated. The answer is simply that if this is done, the bridge will no longer null, due to the phase difference between the voltages across Rm and Z.

A number of questions had to be answered before drafting a specification for a final design.

Firstly, what impedance range should be covered? If loudspeakers or signalling loops are to be checked, impedances down to 1 ohm could be needed. At the top end, 10 megohms seemed a reasonable limit. This range could be accommodated by fitting 6 multiplying resistors with values from 10 ohms to 1 megohm, in conjunction with a ratio scale from 0.1 to 10.

Secondly, the impedance at what frequency? RLC bridges use a single fixed frequency — usually 400 or 1000Hz — and audio impedances are also quoted at these figures. But if we wish to explore, say, the change in impedance of a loudspeaker around the cone resonance point, frequencies as low as 20Hz could be needed, while for tweeters, frequencies at the top end of the audio range would be appropriate.

There is no possibility of providing all this in a simple instrument, so a compromise has been reached. An internal oscillator is provided for R, L and C measurements, while an audio signal generator can be plugged in to provide a measuring frequency anywhere in the audio range.

The internal oscillator is switched to oscillate at either 1592Hz or 159.2Hz. Why such strange frequencies? The answer lies in the relationship between the reactance of a capacitor or inductor, and the value of the capacitor in microfarads, or of the inductor in henries. For example, the formula for a capacitor is:

$$C = 10^6 / 2 \pi f Xc$$

where Xc is the reactance in ohms, f is the frequency in Hertz and C is the capacitance in microfarads.

Now the product of the numbers 159.2 and 2 pi is exactly 1000 so, by choosing the value for f, the above formula simplifies to:

$$C = 1000 / Xc$$

This simplification allows us to calibrate the multiplier switch directly in microfarads, and readings can be made in the same way as they are on a capacitance bridge, without the need to calculate capacitance from reactance.

If the capacitor has appreciable leakage, however, a single reading may be in error. The possibility of having a DC position to measure leakage was considered, but ruled out because of the very high resistances involved, and switching complications.

A technique of excluding the leakage component by measuring the impedance at two frequencies, was developed. A number of combinations were examined, before deciding on two frequencies with a ratio of 10:1. This ratio has the advantage of again simplifying the mathematics.

The ratio dial was given three scales labelled I/P, P and P^2 respectively. These scales function as a simple calculator, enabling the required mathematical functions of squaring, taking the square root, and inverting, to be carried out automatically as the dial readings are taken.

Although the procedures sound complex on first reading, they are only slightly more involved than reading a capacitance bridge, and considerably easier than the bridge measurement of inductance. (In one bridge instruction book, the procedure for finding inductance occupies two pages!)

For capacitance measurement, a single reading at 159.2Hz is all that is usually necessary; if leaking is suspected a check at 1592Hz will confirm it (or otherwise) and the full measuring procedure can be followed (see instructions for using the Meter).

In the same way, the measurement of inductance can be simplified by use of the same frequencies, except that the taking of two readings is almost mandatory, since every inductance has appreciable resistance also. A point in favour of this instrument, is that measuring inductance with simple bridge circuits is next to impossible. One has either to acquire a set of standard inductors — and the writer has never seen one outside a college physics laboratory — or use a bridge circuit in which the inductive reactance is balanced against the reactance of a standard capacitor. Anyone who has used one of these bridges can describe the difficulty of obtaining a measurement; two dials must be turned more or less simultaneously, and "false nulls" are easily made.

The third question to be answered is whether the instrument should be capable of measuring the phase angle between Rm and the unknown impedance. The measurement of phase angle would be only of value here as a means of determining whether an unknown impedance is predominantly capacitive or inductive, and since this can be easily determined by the two

The man behind the project

Ron Salter, who won the EA-Parameters Project Competition with the impedance meter described here, is employed as an Instrument Engineer with Kodak (Australasia) Pty Ltd, having joined the company in 1956. His background includes an Industrial Electronics Certificate from the Royal Melbourne Institute of Technology (RMIT), and the completion of "about 2/3 of an engineering diploma course". He is a member of the Institution of Instrumentation and Control, Australia, and has worked as an evening instructor at RMIT.

Mr Salter describes his main interest as "playing an inexpert clarinet with the Eltham Concert Band".

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S3 – ETI 482A. Preamp Board
S4 – ETI 482B. Tone Control Board
S5 – ETI 485. Graphic Equalizer
S6 – ETI 480. 50 watt Amplifier
S7 – ETI 480. 100 watt Amplifier
S8 – ETI 480 Ps. Power Supply for Above
S9 – ETI 443. Expander Compressor
S10 – ETI 444. Five Watt Stereo
S11 – ETI 422B. Booster Amplifier
S12 – ETI 438. Audio Level Meter
S13 – ETI 440. 25 watt Stereo Amplifier
S14 – ETI 420. Four channel Amplifier
S15 – ETI 420E. SQ Decoder
S16 – ETI 423. Add-on Decoder Amplifier
S17 – ETI 422. 50 Watt per channel Amplifier
S18 – ETI 426. Rumble Filter
S19 – ETI 429. Simple Stereo Amplifier
– ETI 416. 25 Watt Stereo Amplifier
S21 – ETI 417. Over Led Distortion Monitor
S22 – ETI 410. Super Stereo Sound Source Width Control
S23 – ETI 425. Integrated Stereo System
S24 – ETI 427. Graphic Equalizer
S25 – E.A. Playmaster 10 + 10
S26 – E.A. Playmaster 128 40 watt
S27 – E.A. Playmaster 132 40 watt
S28 – E.A. Playmaster 136 13 watt
S29 – E.A. Playmaster 137 3 watt
S30 – E.A. Playmaster 143 12.5 watt
S31 – E.A. Playmaster Twin 25 watt
S32 – E.A. Musicolour II 1000 w ch
S33 – E.A. Musicolour III 1000 w ch
S34 – E.A. Stereo Dynamic Noise Filter

AUDIO TEST UNITS

AT1 – ETI 441. Audio Noise Generator
AT2 – ETI 128. Audio Millivolt Meter
AT3 – ETI 112. Audio Attenuator
AT4 – ETI 102. Audio Signal Generator
AT5 – E.A. A.F. Tone Burst Generator
AT6 – E.A. Laboratory Solid State A.F. Generator
AT7 – ETI 137 Audio Oscillator

TEST EQUIPMENT

TE1 – ETI 134 True RMS Voltmeter
TE2 – ETI 133. Phase Meter
TE3 – ETI 533c. Digital Display 1976 Display
TE4 – ETI 129. R.F. Signal Generator
TE5 – ETI 130. Temperature Meter
TE6 – ETI 706. Marker Generator
TE7 – ETI 709. R.F. Attenuator
TE8 – ETI 122. Logic Tester
TE9 – ETI 124. Tone Burst Generator
TE10 – ETI 123. C Mos Tester
TE11 – ETI 116. Impedance Meter
TE12 – ETI 533. Digital Display 1975 Display
TE13 – ETI 117. Digital Voltmeter 1975 Display
TE14 – ETI 117. Digital Voltmeter 1976 Display
TE15 – ETI 704. Cross Hatch Dot Generator
TE16 – ETI 120. Logic Probe
TE17 – ETI 121. Logic Pulser
TE18 – ETI 118. Digital Frequency Meter 1975 Display
TE19 – ETI 118. Digital Frequency Meter 1976 Display
TE20 – ETI 222. Transistor Tester
TE21 – ETI 113. 7 Input Thermocouple Meter
TE22 – ETI 107. Wide Range Voltmeter
TE23 – ETI 108. Decade Resistance Box
TE24 – ETI 109. Digital Frequency Meter
TE25 – E.A. SWR Reflectometer
TE26 – E.A. R.F. Impedance Meter
TE27 – E.A. Antenna Noise Bridge
TE28 – E.A. 1968 Transistor Test Set
TE29 – E.A. 1971 Transistor (F.E.T.) Tester
TE30 – E.A. 1977 Digital Logic Trainer
TE31 – E.A. 2½ Digit Volt Ohm Meter
TE32 – E.A. Simple Function Generator
TE33 – E.A. Direct Reading Capacitance Meter
TE34 – ETI 487 Real Time Audio Analyser
TE35 – ETI 483 Sound Level Meter
TE36 – ETI 489 Real Time Audio Analyser
TE37 – ETI 717 Cross Hatch Generator
TE38 3 Megahertz Freq Counter
TE40 – E.A. Direct Reading Ohm Meter
TE41 – E.A. Function Generator

WARNING SYSTEMS

WS1 – ETI 583. Gas Alarm
WS2 – ETI 066. Temperature Alarm
WS3 – ETI 528. Home Burglar Alarm
WS4 – ETI 702. Radar Intruder Alarm
WS5 – ETI 220. Wailing Siren
WS6 – ETI 219. Hee-Haw Siren
WS7 – ETI 313. Car Alarm
WS8 – ETI 518. Door Monitor
WS9 – ETI 503. Electronic Thief Trap
WS10 – ETI 506. Infra Red Intruder Alarm
WS11 – ETI 305. Automatic Car Alarm System
WS12 – ETI 582. House Alarm
WS13 – E.A. Electronic Siren
WS14 – E.A. 1976 Car Alarm
WS15 – E.A. 10 Ghz Radar Alarm

PHOTOGRAPHIC

PH1 – ETI 586. Shutter Speed Timer
PH2 – ETI 548. Photographic Strobe
PH3 – ETI 514B. Sound Light Flash Trigger
PH4 – ETI 532. Photo Timer
PH5 – ETI 509. 50 Day Timer
PH6 – ETI 505. High Powered Strobe
PH7 – ETI 513. Tape Slide Synchronizer
PH8 – ETI 512. Photographic Process Timer
PH9 – ETI 515. Slave Flash
PH10 – ETI 540. Universal Timer
PH11 – E.A. 1970 Stroboscope Unit
PH12 – E.A. Sync-A-Slide
PH13 – E.A. Auto Trigger for Time Lapse Movies
PH14 – E.A. Digital Photo Timer

MODEL TRAIN UNITS

MT1 – ETI 541. Model Train Control
MT2 – E.A. 1974 Model Train Control
MT3 – E.A. 1971 S.C.R. P.U.T. Control Unit
MT4 – E.A. Electronic Steam Whistle
MT5 – E.A. Electronic Chuffer

AUTOMOTIVE UNITS

A1 – ETI 317. Rev. Monitor
A2 – ETI 081. Tachometer
A3 – ETI 316. Transistor Assisted Ignition
A4 – ETI 240. High Power Emergency Flasher
A5 – ETI 239. Break Down Beacon
A6 – ETI 312. Electronic Ignition System
A7 – ETI 301. Vari-Wiper
A8 – ETI 502. Emergency Flasher
A9 – ETI 302. Tacho and Dwell Meter
A10 – ETI 303. Brake Light Indicator
A11 – ETI 309. Battery Charger
A12 – E.A. 1970 C.D.I. Capacitor Discharge Ignition
A13 – E.A. High Efficiency Flasher
A14 – E.A. Dwell Meter
A15 – E.A. Variwiper
A16 – E.A. Tacho for Tune-ups
A17 – E.A. Ignition Analyser Tachometer
A18 – E.A. Strobe Adaptor for Ignition Analyser
A19 – E.A. 1975 C.D.I. Capacitor Discharge Ignition
A20 – E.A. Mains Supply for Car Cassettes
A21 – E.A. Automatic Heavy Duty Battery Charger

GUITAR UNITS

G1 – ETI 447. Audio Phaser
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G3 – ETI 424. Spring Reverb Mixer
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G5 – ETI 413. 100 watt Guitar Amplifier
G6 – ETI 410. A.D.U. for your Guitar
G7 – E.A. PM 125 50 watt Guitar Amplifier
G8 – E.A. PM 134 21 watt Guitar Amplifier
G9 – E.A. PM 138 20 watt Guitar Amplifier
G10 – E.A. Waa Waa Unit
G11 – E.A. Fuzz Box
G12 – E.A. Sustain Unit
G13 – E.A. PM 135 12 watt Guitar Amplifier

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P2 – ETI 449. Balance Mic Pre-Amplifier
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P5 – ETI 414. Master Mixer 8 Channel
P6 – ETI 419. Mixer Preamplifier
P7 – ET: 401. F.E.T. 4 Input Mixer
P8 – ETI 485. Graphic Equalizer
P9 – E.A. PM 127 Control Unit
P10 – E.A. Simple Mixer for Pick Up & Microphone
P11 – E.A. PM 145 Mixer

TUNERS

T1 – ETI 062. A.M. Tuner
T2 – ETI 740. FM Tuner
T3 – E.A. PM 138 Tuner
T4 – E.A. PM 146 AM-FM Tuner

VOLTAGE CURRENT CONTROLS

V1 – ETI 481. 12 volt to +40 VDC 100 watt Inverter
V2 – ETI 525. Drill Speed Controller
V3 – E.A. S.C.R. Speed Controller
V4 – E.A. Stage (etc.) Auto Dimmer 2 K.W.
V5 – E.A. Stage (etc) Auto Dimmer 4 K.W. & 6 K.W.
V6 – E.A. 1976 Speed Control

POWER SUPPLIES

PS1 – ETI 132. Experimenters Power Supply
PS2 – ETI 581. Dual Power Supply (High Powered Version)
PS3 – ETI 712. CB Power Supply
PS4 – ETI 131. Power Supply
PS5 – ETI 119. 5 Volt Switching Regulator Supply
PS6 – ETI 105. Laboratory Power Supply
PS7 – ETI 111. I C Power Supply
PS8 – E.A. D.C. Voltage Reference
PS9 – E.A. 1976 Power Supply
PS10 – E.A. Dual 30-2 0-30V @ 2A or 0-60V @ 2A or Dual Pos and Neg 30V @ 2A
PS11 – E.A. CB Power Supply
PS12 – E.A. Dual Regulated Supply

RECEIVERS TRANSMITTERS

R1 – ETI 711. Remote Control Transmitter Switch
R2 – ETI 711R. Remote Control Receiver
R3 – ETI 711D. Remote Control Decoder
R4 – ETI 711B. Single Control
R5 – ETI711C. Double Control
R6 – ETI 711P. Power Supply
R7 – ETI 707A. 144MhZ Converter
R9 – ETI 708. Active Antenna
R10 – ETI 710. R.F. Power Amplifier
R11 – ETI 780. Novice Transmitter
R12 – ETI 703. Antenna Matching Unit
R13 – E.A. 1967 All Wave 7
R14 – E.A. 240 Communications Receiver
R15 – E.A. 110 Communications Receiver
R16 – E.A. 160 Communications Receiver
R17 – E.A. 130 Communications Receiver
R18 – E.A. All Wave I C 2
R19 – E.A. Deltahet Solid State Mk2 Communications Receiver
R20 – E.A. Fremodyne 4 Complete Kit
R21 – E.A. Fremodyne 4 RF Section
R22 – E.A. PM 138 Tuner-Receiver
R23 – E.A. Mos Fet 52Mhz Converter
R24 – E.A. 2-6Mhz Converter
R25 – E.A. 8-19Mhz Converter
R26 – E.A. 100Khz Crystal Calibrator
R27 – E.A. 1Mhz Crystal Calibrator
R28 – E.A. V.H.F. Power Match
R29 – E.A. Short Wave Converter for 27Mhz
R30 – E.A. Simple S.W.R. Meter
R31 – E.A. 27Mhz Pre-Amp
R32 – E.A. 10-30Mhz Pre-Amp

COMPUTER & DIGITAL UNITS

C1 – ETI 633. Video Synch Board
C2 – ETI 632M. Part 1 Memory Board V.D.U.
C3 – ETI 632P. Part 1 Power Supply V.D.I
C4 – ETI 632A. Part 2 Control Logic V.D.U.
C5 – ETI 632B. Part 2 Control Logic V.D.U.
C6 – ETI 632C. Part 2 Character Generator V.D.U.
C7 – ETI 632. Mother Board inc. P S
C8 – ETI 632U. (U.A.R.T.) Board
C9 – ETI 631-2. Keyboard Encoder
C10 – ETI 631. A. Sch. Keyboard Encoder (less keyboard)
C11 – ETI 670. Hex Display
C12 – E.A. Educ-8 Computer
C13 – E.A. Cassette-Tape Interface

MISCELLANEOUS KITS

M1 – ETI 604. Accentuated Beat Metronome
M2 – ETI 546. G.S.R. Meter
M3 – ETI 549. Induction Balance Metal Locator
M4 – ETI 547. Telephone Bell Extender
M5 – ETI 602. Mini Organ
M6 – ETI 544. Heart Rate Monitor
M7 – ETI 044. Two Tone Doorbell
M8 – ETI 043. Heads or Tails
M9 – ETI 068. L.E.D. Dice Circuit
M10 – ETI 539. Touch Switch
M11 – ETI 529. Electronic Poker Machine
M12 – ETI 236. Code Practice Oscillator
M13 – ETI 218. Monophonic Organ
M14 – ETI 701. Masthead Amplifier
M15 – E.A. I C Volume Compressor
M16 – E.A. Geiger Counter
M17 – E.A. Electronic Anemometer
M18 – E.A. 240 Volt Lamp Flasher
M19 – E.A. A C Line Filter
M20 – E.A. Bongo Drums
M21 – E.A. Keyless Organ
M22 – E.A. Auto Drums
M23 – E.A. Electronic Roulette Wheel
M24 – E.A. Video Ball Game
M25 – E.A. Digital Metronome
M26 – E.A. Voice Operated Relay
M2 – E.A. Gas Detector
M28 L.E.D. Chaser
M29 Sound Effects

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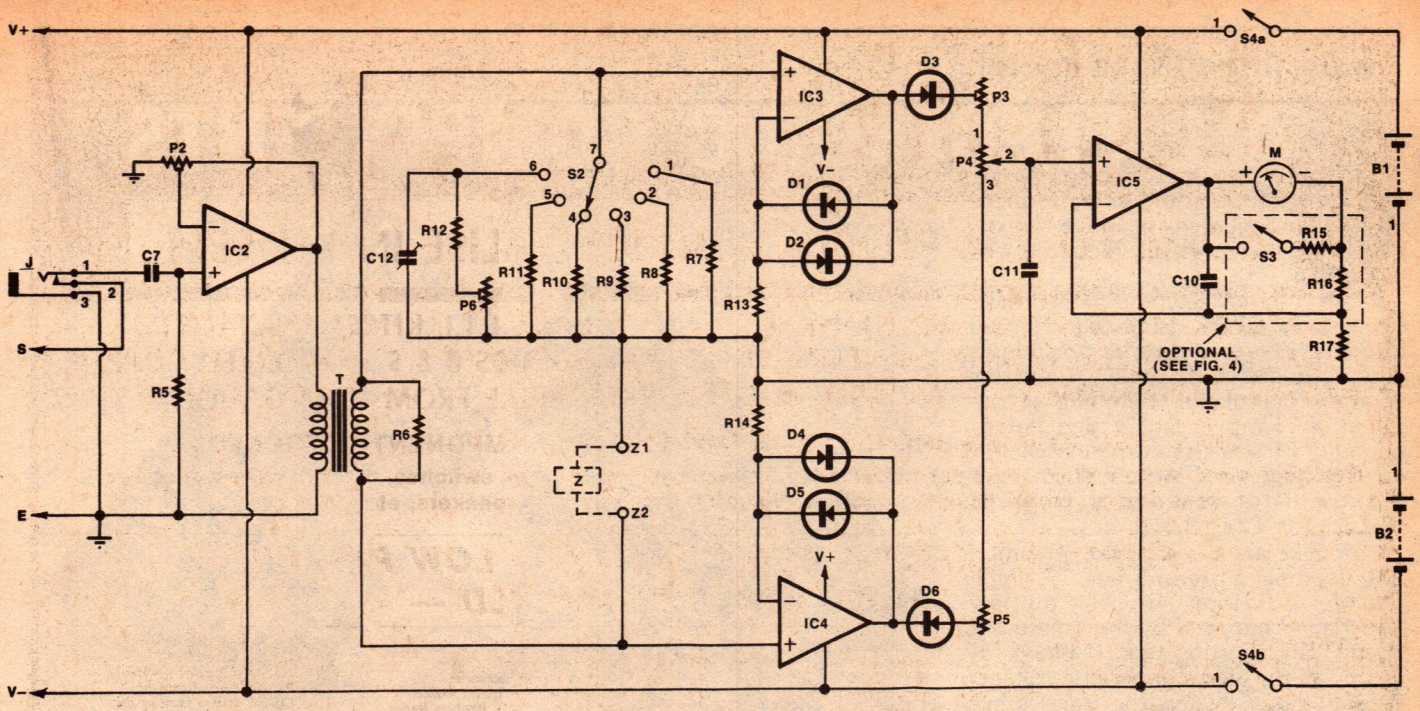
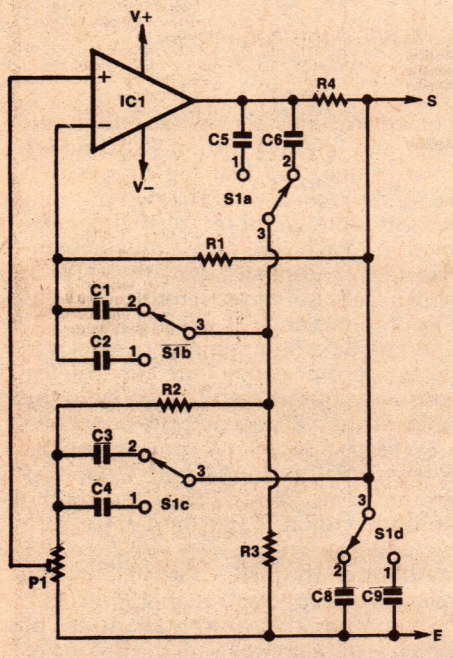


The main circuit diagram is shown at top, while below is the circuit for the optional internal oscillator.



frequency method, there is little point in providing phase indication, since considerable extra circuitry would be required.

Turning now to the circuit diagram, IC1 is the two-frequency oscillator, which may be omitted if a calibrated signal generator is available; the frequency switch is placed on the side of the box, so that the front panel layout can be left undisturbed.

The oscillator is unusual, in that the frequency determining network has two outputs, the first of which gives a voltage null at the oscillation frequency, and the second gives a voltage which peaks, and is in phase with the

PARTS LIST

1 Plastic case, 196 x 112 x 60mm, with aluminium lid.
1 PC board 55mm x 155mm 78/im/12 (fibreglass preferred).

M 1 Edge-reading centre-zero meter, 400-0-400uA, 600 ohms.
1 Large knob (Sato or similar).
1 Small knob (Sato or similar).

J. 1 Miniature (3.5mm) phone jack.

T 1 Miniature audio transformer, Trimax type TA2320, 1k CT/50 ohm CT.

S2 1 Single pole 6-position rotary switch.

S3, S4 2 DPDT sub-miniature slide switches.

P2 1 100k preset pot, 0.1in pin spacing.

P3, P5 2 1k preset pots, 0.1in pin spacing.

P6 1 500k preset pot, 0.1in pin spacing.

P4 1 10k 3W wirewound pot (I.R.C.)

B1, B2 2 9-volt batteries, type 216, and connectors.

2 Binding posts, one red, one black.

ICs 2, 3, 4 & 5
5 uA741 op. amp., 8-pin DIL case.

Ds 1, 2, 3, 4, 5 & 6
6 1N34A germanium diodes.

RESISTORS:

R5 1 100 ¼W or ½W 5%.
R6, R17 2 100 ohm ¼W or ½W 5%.
R7 1 10 ohm ½W or 1W 2% or better.
R8 1 100 ohm ½W or 1W 2% or better.
R9 1 1k ½W or 1W 2% or better.
R10 1 10k ½W or 1W 2% or better.
R11 1 100k ½W or 1W 2% or better.
R12 1 820k ½W or 1W 5%.
R13, R14 2 8.2k ¼W or ½W 5%.
R15 1 180 ohm ¼W or ½W 5%.
R16 1 10k ¼W or ½W 5%.

CAPACITORS:

C7, C10 2 1uF metallized polyester.
C11 1 10uF 25 or 50VW non-polarised electrolytic.
C12 1 50pF trimmer.

MISCELLANEOUS:

4 rubber feet; 2 right-angle brackets (can be made from aluminium sheet); PC pins for wires to switches, etc; pointer for ratio knob, screws, nuts, washers and solder.

FOR OSCILLATOR OPTION:

S1 1 4-pole 2-position rotary switch.
1 small knob (Sato or similar).
R1, R2 2 10k ½W or 1W resistors, 2% or better.
R3, R4 2 1k ½W or 1W resistors, 2% or better.
P1 1 100k preset pot. 0.1in pin spacing.
IC1 1 uA741 op. amp., 8-pin dual in-line case.
C1, C3 2 .01uF polyester capacitors, 2% or better.
C2, C4 2 0.1uF polyester capacitors, 2% or better.
C6, C8 2 0.1uF polyester capacitors, 2% or better.
C5, C9 2 1.0uF polyester capacitors, 2% or better.

GAIN CONTROL OPTION:

P7 1 10k miniature pot with knob.

oscillator output, at the same frequency. This arrangement produces an oscillator with an unusually high frequency stability[3]

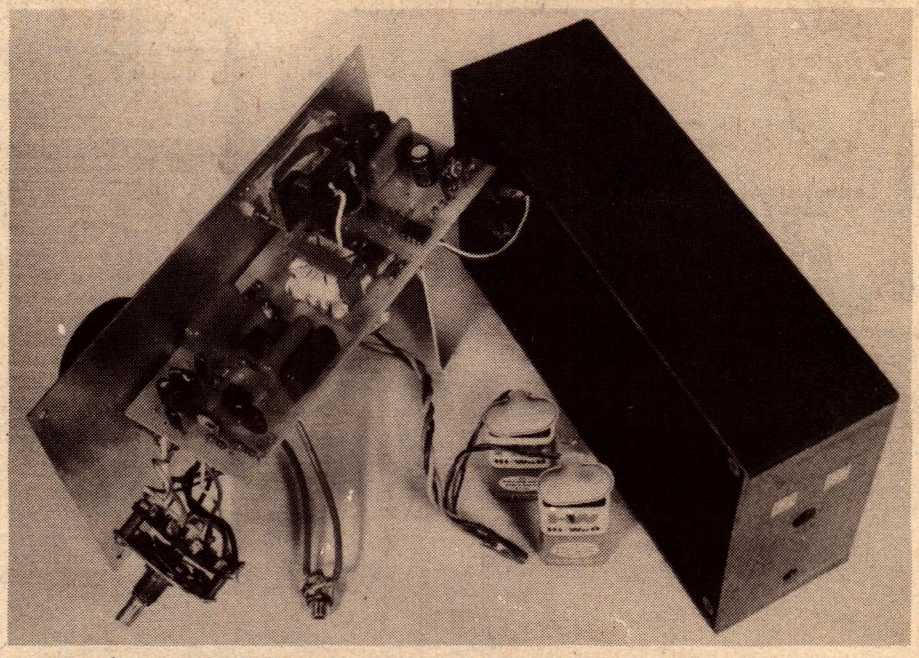
Close tolerance components have been specified to ensure that the two frequencies are as close as possible to design requirements, but if a frequency counter is available, trimming of the values of R1 and R2 can be tried. Potentiometer P1 sets the correct oscillator drive voltage, and switch S1 changes the oscillator frequency from F1 (159.2Hz) to F2 (1592Hz).

The next stage is a buffer op. amp., IC2, feeding a transformer T, which provides a floating output at the low impedance required by the measuring circuit. The shorting jack, J, allows injection of the signal generator voltage. Potentiometer P2 sets the transformer drive voltage. The oscillator signal to the buffer is taken, not from the oscillator op. amp. output, but from the junction of R4 and R1. The waveform of this point contains less distortion than the op. amp. output, because it is in effect the output of a low-pass filter formed by R4, and either C8 or C9, whichever is switched in circuit.

A word about the transformer. Because the secondary winding is floating with respect to earth, interwinding capacitance has a big effect on the calibration at high frequencies. The transformer specified was chosen after numerous tests, and although others of similar specification would no doubt work, the unit may be difficult to calibrate. The phasing of connections to the primary and secondary winding is also important, and this is taken care of by the arrangement of the PCB conductors.

Even with these precautions, it has not been possible to achieve linear calibration above 1 megohm, particularly at frequencies above about 2kHz. Compensation on the 1 megohm range is provided by P6 and C12, but calibration curves are still needed. There is also some departure from linearity at very low impedances.

The transformer secondary winding supplies voltage to the multiplier resistor Rm, and the unknown impedance Z, connected in series and earthed at the common junction. A switch S2 selects the value of Rm. The voltage drops across Rm, and the unknown Z, are fed to IC3 and IC4 respectively.



A printed circuit board accommodates nearly all of the components.

These two operational amplifiers, in conjunction with diodes D1 to D6, function both as high input impedance voltage followers and as linear rectifiers.

Looking now at IC3 and diodes D1 to D3, feedback is taken from the IC output to the inverting input, via diodes D1 and D2. This introduces a voltage delay in the feedback signal, which allows full op. amp. gain when the input voltage is at or close to zero, but it reduces the gain to unity when D1 and D2 start to conduct. The input to D3 rises very quickly from the zero crossing point, to the point of conduction of D3, making this diode act as a linear rectifier. This circuit was preferred to the more usual arrangement of taking the feedback signal from the output of D3, because the input impedance and frequency response of the simpler circuit were both too low for the purpose.

The output of D3 is therefore a half-wave positive impulse, equal in amplitude to the AC voltage drop across Rm. Similarly, the output of D6 is a half-wave negative impulse, equal in amplitude to the AC voltage drop across Z.

Trimming potentiometers P3 and P5, and ratio potentiometer P4, are connected in series across these two outputs, and in effect form the second leg of a bridge, the first leg of which is formed by Rm and Z. The two portions of the potentiometer resistance element on each side of the moving contact form resistance arms, the ratio of which can be varied continuously as the potentiometer is adjusted.

When the potentiometer contact is in such a position that the ratio of the resistance of these arms is equal to the ratio of the voltage outputs of D3 and D6, the potentiometer moving contact is at zero DC potential with respect to ground. This point is detected by the null detector IC5 and the centre-zero meter M.

Although the DC potential at the contact is zero, there is an appreciable AC component, the magnitude of which is dependent upon the degree of phase shift between the AC voltages across Rm and Z. This AC component is filtered out by capacitor C11.

The null detector gain has two settings, controlled by S3. An optional arrangement uses a continuously variable potentiometer as in Fig. 4. The high gain position is provided mainly for those situations in which it is advisable to reduce the signal voltage to avoid damage to the device being measured; for example, pickups or microphones. The calibration will be approximate only under these conditions. C10 is included to prevent oscillation in the null detector circuit.

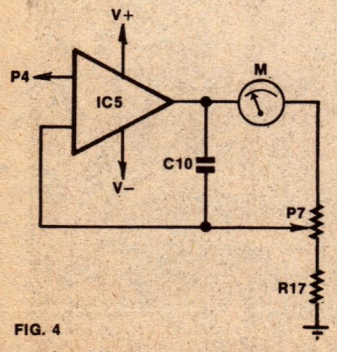


FIG. 4

Optional null detector arrangement.

(continued next month)

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FV-901DM Synthesised scanning external VFO, 40 memory storage, electronic tuning, etc. **$475.**
FC-901 Antenna coupler, 500w, inc. SWR and PWR meters, ant. switch and connectors, **$272.**
YO-901 Multiscope. This is a CRO, TX monitorscope with two-tone generator, and receiver panascope! **$TBA.**
SP-901 External speaker **$56.**
SP-901P. External phone patch/speaker. **$135.**
FTV-901 VHF/UHF/OSCAR. Transverter for 50, 144 and 430 MHZ. **$TBA.**
CW and AM Filters, $63 each. Elect. keyer unit **$48.** Memory **$172.** DC-DC unit **$86.** FM **$58.**

Whether you are looking for a first class singer/entertainer or first class communications equipment, you must be as discerning as we were. Pictured is popular Melbourne soprano, Margaret Smith of Mount Waverley with the top of the range from Yaesu.

FT-101E TRANSCEIVER: 160-10 Mx, SSB, AM, CW, PA two x 6JS6C, 260W PEP input SSB. 240V AC BUILT-IN RF SPEECH PROCESSOR. Solid state except for TX. PA and driver. IF noise blanker, FET Rx RF amplifier, clarifier, built-in speaker. Mic., English Language inst. Book, connectors and Pwr. cable inc. **$889.**
FT-101E W/DC FACTORY INSTALLED. **$945.** (FT-101E's imported by B.E.S. now inc. a more effective, adjustable N.B.)
101E DC-DC CONVERTER KIT $60.
FV-101B EXT. VFO $169.
SP-101B EXT. SPEAKER 8ohm **$49.**
SP-101PB EXT. PHONE PATCH/SPKR $135.
YO-101 Monitorscope, inc. built-in two-tone. **$399.**
YC-601B DIGITAL READOUT ADAPTOR for FT-101E, with built-in AC PS. Includes frequency counter to 30 MHz. **$318.**
M-101 MOBILE MOUNT for FT-101E. **$38.**
CRYSTAL FILTERS for CW and AM. **$63 each.**
FL-2100B LINEAR AMPLIFIER: 80-10Mx, uses 2 x 572B triodes in G.G. twin fan cooled, styled to match FT-101E. Equally suitable for other rigs. **$585.**
L **FT-301 160-10mx.** Fully solid state Tcvr, built in RF Speech Processor, 200W PEP Input. **$898.**
L **FT-301D DELUXE DIGITAL Tcvr.** Similar to FT-301, **$999.**
* *L* **FP-301 MATCHING POWER SUPPLY.** 20 Amp 12V suit all 301 Transceivers. **$195.**
YO-301 MATCHING MONITORSCOPE for FT-301 Series. **$399.**
FC-301 ANTENNA COUPLER 500W, inc. SWR & Pwr meters, ant. switch and connectors. **$258.**
R-301 RELAY BOX for FT-301 to FL-2001B. **$23.**
FT-7 TRANSCEIVER, 80-10m, for novice and mobile. 20W all solid-state. **$565.**
FT-7B TRANSCEIVER, as FT-7 but with full coverage of 10M Band (28.5-29 installed), 100W peak input, and other additional features. **$685.**
FL-110 SOLID STATE LINEAR AMPLIFIER. 10-15W drive, 200W PEP Input, 160-10mx. **$259.**
I **FL-101 TRANSMITTER:** Solid state 160-10m, PA two 6JS6C, all facilities. Companion unit to FR-101. **$895.**
I **FL-101 SPEECH PROCESSOR:** For installation in FL-101 **$95.**
I **FR-101D RECEIVER:** All solid state, 23 bands incl. all amateur bands 160-10m plus 6 and 2m, FM, CW, etc., etc. **$1245.**
I **FR-101D DIGITAL:** Has all the options of the FR-101D as well as DIGITAL READOUT. **$1455.**
(FR-101 requires 8 ohm speaker)
FRG-7 WADLEY LOOP RECEIVER: All solid state, 0.5-29.9 MHz in thirty 1MHz bands. Electronic band selection. **$389.**
BATTERY HOLDER FOR FRG-7, holds 8 size "D" cells for internal battery operation. **$10.00.**
FRG-7000 WADLEY LOOP RECEIVER: Improved version of FRG-7, extended freq. coverage, digital readout, digital clock etc. **$695.**

FT-625 and **FT-225** VHF Transceivers. Feature all mode of operation — SSB/FM/CW/AM — with repeater offset capability, using advanced phase-locked loop circuitry. AC and DC operation. Similar styling to FT-901.
(FT-225, 144-148 MHz., FT-625, 50-54 MHz)
R model, analog dial. **$895.**
I **RD,** analog & digital. **$995.**
I **RDM.** Analog, digital & memory. **$1175.**
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I **FTV-650B SIX METRE TRANSCEIVER:** Converts 28 MHz. SSB to VHF, and includes receiving converter. 50W PEP. Primarily designed for coupling with Yaesu transmitters **$290.**
I **FTV-250 TWO METRE TRANSVERTER:** Similar FTV-650B. 10W-15W output, but all solid state and built-in AC PS. **$348.**
L **FT-227R** 2mx, 10W FM Tcvr, 800 Ch, with Dig. Readout, memory, rev. etc. **$365.**
L **FT-227RA,** Similar FT-227R but with four memory channels and PLL scanner with control from microphone. **$399.**
L **CPU-2500R** 2M, 25W FM Transceiver with PLL synthesis in 5 KHz steps, controlled by a central processing unit. Four memory chans., with scanning.
CPU-2500R, with standard mic. with up/down scanner controls. **$545.**
CPU-2500R, with keyboard mic., allowing remote input of dial or memory chans., programming of repeater splits, scanner control, and tone pad. **$585.**
I **YC-500E 500MHz FREQ. COUNTER:** Accurate to .02ppm. **$656.**
I **YC-500S 500MHz FREQ. COUNTER:** Accurate to 1ppm. **$499.**
I **YC-500J 500MHz FREQ. COUNTER:** Accurate to 10ppm. **$368.**
YP-150 DUMMY LOAD/POWER METER: For use over the frequency range 1.8-200 MHz, Three power ranges, 0-6W, 0-30W, 0-150W with built-in cooling fan. **$112**
FF-501DX 3-SECTION L.P. FILTER for TVI reduction. Includes two PL-259 co-ax plugs. **$39.**
F-101 FAN. $38.
YD-844 DESK MICROPHONE: Yaesu De Luxe PTT Dynamic type with stand, spring and lock PTT switches. PTT also actuated when lifted from deck. Dual imp. 600/50K. Inc. connector. **$49.**
YD-148 DESK MICROPHONE: Flexible Goose Neck type. 600/50K. Inc. connector. **$49.**
HAND MICS. FOR YAESU, YD-846 etc. with connector. **$21.50**
YH-55 YAESU HEADPHONES: 8 ohm. **$19.00.**
SERVICE MAINTENANCE MANUALS: FT-101 **$27.** FT-221. **$19.**
RS SERIES HF GUTTER MOUNT MOBILE ANTENNAS: RS Base and Mast (doubles as ¼ wave on 2m), complete, inc. co-ax lead attached RSE-M2. **$29.90.** Coil and Tip Rods: RSL-3.5. **$22,** RSL-7 **$21,** RSL-14 **$20,** RSL-21 **$19,** RSL-28 **$19,** RSL-145 (5/8 2M) **$24.**

Special, $ Reduced! Limited stocks only.

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SR-C146A. 2m hand held 5 chan. 2W transceiver, inc. carrying case and 3 chns.	**$199.00**
SR-C432A, 70cm hand held 6 chan. 2W transceiver, inc. carrying case and 1 chn (435 MHz)	**$225.00**
STANDARD ACCESSORIES	
CMP08 Hand mic. for SR-C146A and SR-C432	**$25.00**
CAT08 Rubber antenna (helical) for SR-C146A	**$10.00**
Heavy Duty Carrying Case for hand held units	**$16.50**
AC Adapter and charger for hand held units	**$35.00**
Mobile Adapter for hand held units	**$14.50**
AC Charger only	**$11.00**
Ni-CAD Penlight Cells, type AA	**$2.90**

ANTENNA ACCESSORIES

LA-1, Lightning Arrestor, for installation in standard 52 or 72 co-axial feedline, designed to Mil. specs.	**$76.00**
LA-2, smaller size co-ax arrestor	**$4.95**
BN-86 Hy-gain ferrite Balun, 2 kW, 1:1	**$30.00**
VS-BN Hidaka ferrite Balun 2 kW 1:1	**$26.00**
VS-BN4 Hidaka similar VS-BN, 300 ohms	**$26.00**
BA-1 Western ferrite Balun 2 kW 1:1, light weight	**$22.00**
HN31 Dummy Load Cantenna Kit 1 kW oil cooled (oil not included)	**$45.00**
FF-501DX Low Pass Filter, 3 Section, 1 kW	**$39.00**
LP-7 TVI Filter low power	**$9.00**
KW Electronics L.P. Filter, 5 Section, 1 kW	**$59.90**
TV-42 Drake L.P. Filter, 3 Section, 300 W	**$19.00**
TV-476 Hy-Gain L.P. Filter, 150 W	**$15.00**
TV-75 Drake High-pass filter 50MHz UP	**$15.00**
Porcelain Egg insulators	**50 cents**

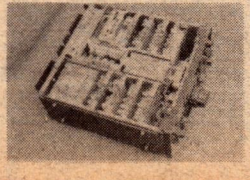
WIDE RANGE of Co-axial cable and connectors in stock.

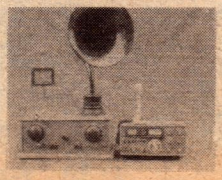
Multi-band dipole traps centre insulator, 80-10m bands per pair, complete with insulator, KW	**$38.00**
Western	**$35.00**
590G B & W co-ax. switch, 5 posn., rear entry	**$39.90**
TWS-120 2 position co-ax switch	**$18.00**
ASW-1, Western 5 position co-ax. switch, side entry	**$33.00**
RS-107 Transceiver tester	**$68.00**
RS-501 Ant. Impedance bridge, inc. 1 osc.	**$72.00**
Extra Osc. for RS-501	**$16.00**

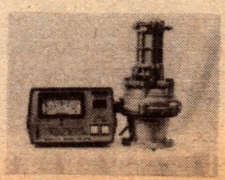
SCALAR MOBILE WHIPS

M-22T ¼ wave 2m whip top	**$6.50**
M-25 5/8 wave 2m whip top	**$16.50**
M-40T 4.5 dB Gain, 435 MHz	**$19.80**
M.B. Standard base	**$4.70**
M.B. UHF base	**$5.80**
MAGBASE inc. 12ft. of RG-58/AU	**$49.00**

bail







SWR AND POWER METERS

SWR-40, REACE single meter type, combined SWR and FS meter, 50 ohms, inc. FS pick-up whip, size 5" x 2" x 2¼". 3-150 MHz, UHF connectors **$19.00**

FSI-5, REACE — dual meters, 50 ohms. Simultaneous reading of forward and reflected power, 5" x 2" x 2¼". 3-150 MHz, UHF connectors. Very sensitive, ideal low power use. **$29.00**

RS-101 Small size SWR meter, with brackets to mount under dash for mobile **$7.50**

ME-11X, ASAHI dual meter **$22.00**

SWR-200 Osker-Block large dual meters, switched 50-75 ohms, with calibration chart for direct power readings to 2 kW in three ranges. A very elegant instrument. 75/8" x 2¾" x 3¾" **$75.00**

FS-600A Hansen Peak Reading Wattmeter SWR meter 20, 200, 500 and 1000 watts 230 VAC operation. 3.5-30 MHz, ... **$78.00**

ANTENNA COUPLERS

HC-75 Tokyo Hy-power labs. Trans-match 75w PEP **$77.00**

HC-250 Tokyo Hy-power labs. 250w **$95.00**

HC-500A Tokyo Hy-power labs. inc. 160m x 500w PEP **$159.00**

HC-2500 Tokyo Hy-power. Trans-match 2.5 kw PEP Limited stocks only at old price **$256.00**

VHF ANTENNAS

VS-2GH 2m 5/8 wave ground-plane **$49.00**

VS-6D 4-element 6m Beam **$68.00**

VS-6GH 6 metre 5/8 wave G.P. **$59.00**

VS-07GH 430 MHz 5/8 G.P. **$45.00**

ARX-450, 435 MHz three half wave 6dB Ringo **$45.00**

432-15H 15-element 430-440 MHz Beam **$65.00**

VS-2GL 7 element 2m Beam **$48.00**

VS-2IL 9 element 2m Beam **$66.00**

ROTATORS

Emotator:

103LBX Medium duty, disc brake **$179.00**

502CXX Heavy duty, disc brake **$259.00**

1102MXX Heavy duty, mechanical brake **$389.00**

1211 Mast clamp for 103LBX **$18.00**

1213 Mast clamp for 502CXX **$29.50**

300 Mast Stay bearing **$32.00**

301 Tower top bearing **$32.00**

High quality tough PVE insulated cable especially for external use with rotators

VCTF-7, 7 core cable (for 1100 series) .... **$1.40** per m

VCTF-6, 6 core (for 103 & 502) .... **$1.25** per m

1103MXX Extra Heavy Duty, high turning torque **$410.00**

1215 Mast clamp for 1102/3 .... **$45.00**

Flexible coupler 451 (for 1102/3 & 502) **$32.00**

Flexible coupler 450 (for 103) **$16.00**

VHF MOBILE ANTENNAS

AS-2HRF 5/8-wave cowl mount type **$39.00**

VS-07MG 70cm Mag Mount ¼ wave **$19.00**

HOPE-2R 2 metre gutter mounted helical, only 22 cms long, incl. co-ax connector **$26.00**

VS-TOWN 2 metre flexible helical on PL-259 .... **$19.50**

VS-MM, magnet mount for VS-TOWN, incl. co-ax **$20.00**

HU-2HR Hidaka 2 metre 5/8 wave 6m ¼ wave gutter mount incl. co-ax and connector **$39.00**

DENSO 430 anti-corrosive compound for jointing antenna and beam elements (as used by electrical authorities). Per tube **$2.90.**

ANTENNAS AND ANTENNA ACCESSORIES

HF MONOBANDERS

VS-20CL 3 elem. W.S. 20m beam, **inc. Balun** **$199.00**

VS-11CM 3 element 10/11m **inc. Balun** **$95.00**

VS-15CM, 3 element 15m. **inc. Balun** **$128.00**

HF DUO BAND

VS-22 Hidaka 3 element 15-11/10m, **inc. Balun** **$179.00**

HF TRIBAND BEAMS

TH6DXX, 6-element trap Beam **$339.00**

TH3Jr, 3-element trap Beam **$195.00**

HY-QUAD 2-element Quad Beam **$237.00**

VS-33 Hidaka (Equiv. TH3Mk3), **inc. Balun** **$265.00**

DX-33 Western (UK) similar TA-33 .... **$240.00**

HF MULTIBAND TRAP DIPOLE

TD-1 Western (UK), 10 THRU 80m. Approx. 110 ft. (34m), ready made with traps, insulators and HD copper wire. Use co-ax or low imp. twin line feeder (not supplied) **$68.00**

FITTINGS: (Suit all makes with 3/8" x 24 thread)

BPR, bumper mount **$22.00**

BDYF, heavy duty adjustable body mount **$24.00**

VS-BM Ball Mount & Medium Duty Spring **$20.00**

VS-BPM Bumper Mount **$18.00**

HIDAKA

VS-LBM Ballmount & H.D. Spring **$25.00**

H.D. Spring **$18.00**

AS-GM Guttermount **$18.00**

VS-NGM Guttermount inc. M ring and Co-ax. **$24.00**

HF VERTICALS

VS41/80KR Hidaka 10m thru 80m, ... **$129.00**

VS-RG Radial Kit for VS-41/80 KR **$35.00**

VS-TR, loaded rod radial kit, 10-80m **$69.00**

18V 10m thru 80m base loaded, exc. portable ant. **$45.00**

Million V1 10/11 metre ½ wave 3.75 dB Ringo **$29.90**

HF MOBILE WHIPS AND FITTINGS

AS-303 HF Mobile antenna set, centre loaded, incl. heavy duty ball mount and spring **$139.00**

AS-NK matching SS Bumper Mount for AS-303 .... **$20.00**

OTHER ACCESSORIES

EKM-1A Audio Morse CP Osc with speaker, one transistor, and tone control, requires one UM3 cell, in metal case 3-5/8" x 2½" x 1-1/8" **$16.90**

TC-701 Morse Practice Osc. with built-in key and spkr. Inc. battery and auxiliary earpiece. Copy of morse code on case. Two can be wired together to form a practice communication set **$19.50**

MORSE KEYS, by KATSUMI & HI-MOUND

EK-150S Single Paddle Electronic Keyer **$149.00**

EK-150D Double paddle electronic keyer **$149.00**

MK-1024 Programmable Keyer, 1024 bit memory **$265.00**

HI-MOUND

HK-808 De luxe heavy duty morse key. Heavy base A beautifully constructed and finished unit. Fitted with a dust cover, standard knob and knob plate. Ball bearing shaft. Precise, firm adjustments. This is a really superb "professional" key and a delight to use. Worth every cent of **$85.00**

HK-70 Heavy duty, lower cost version of 808 .... **$47.00**

HK-706 Operators key **$25.00**

HK-707 Standard key **$19.50**

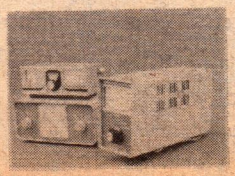
HK-708 Economy, with flat knob **$17.00**

HK-707, with dust cover and standard knob. On standard base **$19.50**

MK-701 Side Swiper key to actuate an Electronic keyer **$39.00**

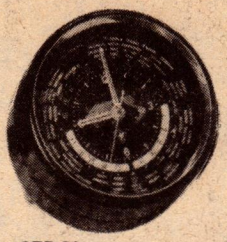
BK-100 (BUG) Semi-automatic bug key, fully adjustable **$49.00**

VALVES for Yaesu equipment, 572 B **$59.00,** 6KD6 **$12.50,** 6JS6 **$11.00,** 6JM6 **$12.00,** S2001 **$13.50,** 12GB7 **$10.00,** 7360 **$22.00,** 6GK6 **$6.50.** 6146B **$16.00,** 12BB14 **$10.50.**



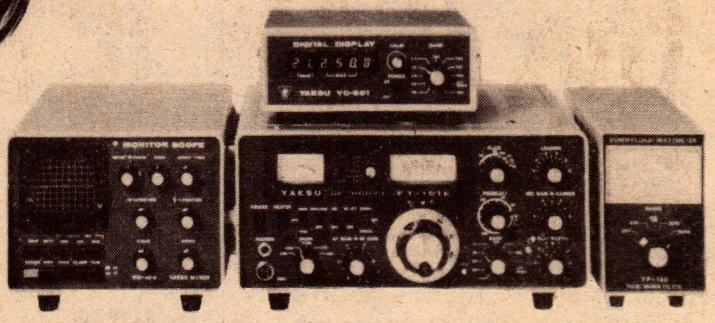
QTR-24

24 hour World Clock $35



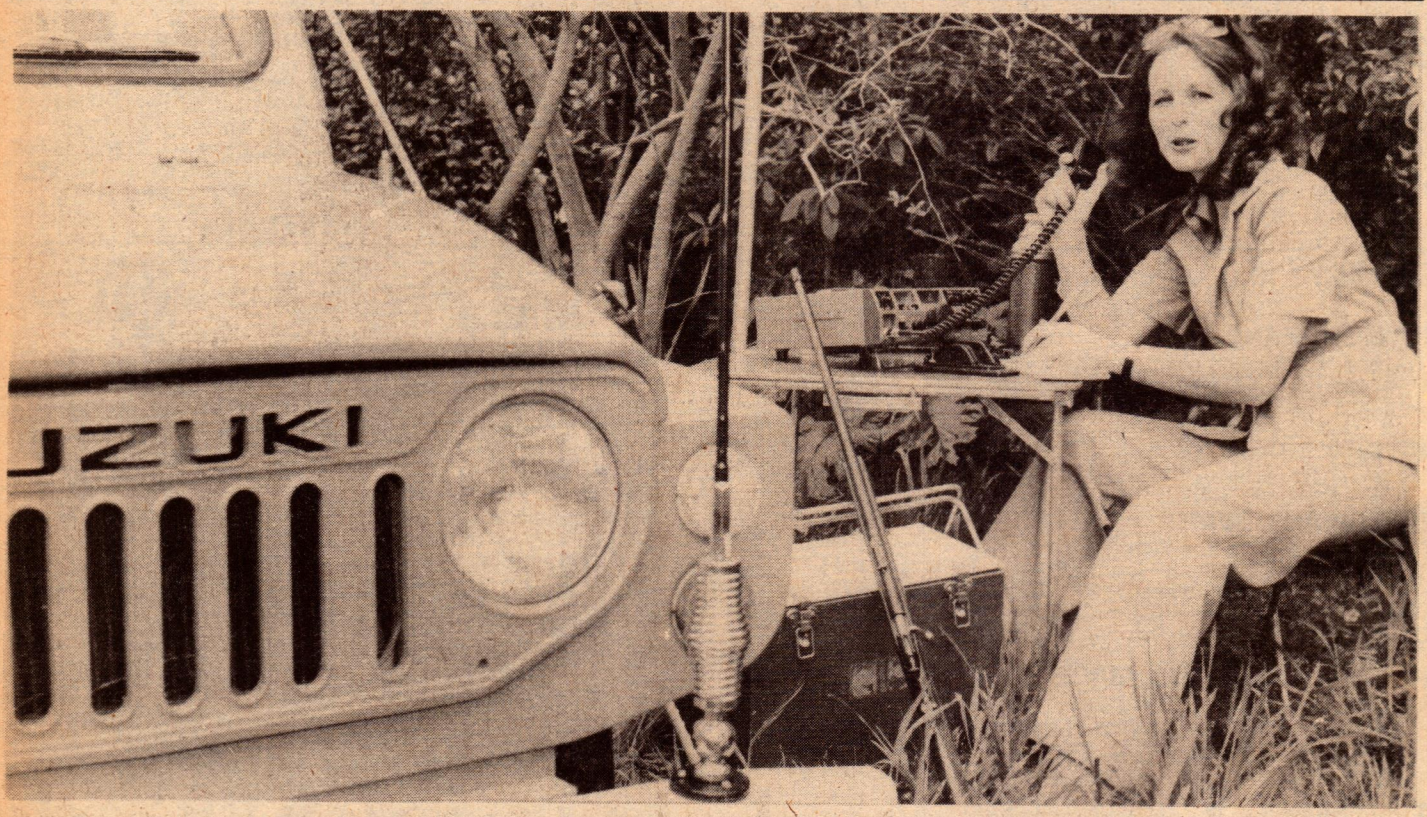
QTR-24

Also shown in the photograph is the YO-101 monitorscope. FT-101E transceiver. YC-601B digital readout adapter and YP-150 dummy load-power meter.



Now an addition to YAESU'S range of measuring instruments . . .

Yaesu has now made an addition to their already well known range of measuring instruments, it is the QTR-24, a 24 hour World Clock. With a glance the time in any principal city or time-zone can be simultaneously co-ordinated with local time on a 24 Hour basis. The QTR-24 is powered by a 1.5V dry cell, which has a normal life of approximately one year. No amateur or SWL station could be complete without one.



*Power Supply Price applies only with purchase of matching transceiver.

As the authorised Yaesu agent and factory representative for Australia since 1963, we provide after-sales services, spares availability, and 90-day warranty except power valves and semi-conductors.

Quote type of set, serial number, date of purchase, and inv. no. when ordering spares. All prices include sales tax. Freight is extra. Prices and specifications subject to change without notice. Allow 50c per $100 for insurance. Availability depends on stock position at time of ordering. Send 50c postage for latest Yaesu catalogue.

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	WILLIS TRADING CO., 429 Murray Street, Perth 6000	Ph. 21 7609
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TAS.	G. T. ELECTRONICS, 131 Westbury Rd., Sth. Launceston 7200	Ph. 44 4773
	PRINS RADIO, 123 Argyle Street, Hobart 7000	Ph. 34 6912
	J. D. ELECTRONICS, 64 Wentworth St., Launceston 7250	Ph. 44 5000
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QLD.	H. C. BARLOW, 92 Charles St., Aitkenvale, Townsville 4814	Ph. 79 8179
	MITCHELL RADIO CO., 59 Albion Rd., Albion 4010	Ph. 57 6830
A.C.T.	QUICKTRONIC, Jim Bland, Shop 11, Altree Crt., Phillip 2606	Ph. 81 2824 82 2864

Digital readout for the ICOM IC22S

This digital readout will make a versatile adjunct to your Icom IC22S 2M transceiver. It is easy to construct and does not deface the set either physically or electrically. Common C-MOS ICs are used throughout, and printed boards make construction quite simple. The readout always indicates the actual operating frequency, even on repeaters.

by MARK HOPKINS*
VK2BME

The popularity of the ICOM IC22S two metre transceiver is now well established. This is undoubtedly due to its low cost, its versatility, and its ease of channel selection. A digital readout and scanner for it should also be popular, since it will add to the versatility of the set.

A scanner is a very useful item, as amateurs who have used one will agree. But to get any use from one on the 22S a digital readout is required in order to know where the scanner is at any time. The readout to be described is virtually self-contained and may be built as a project on its own without the scanner. The scanner can be added later if desired, and will be the subject of a separate article.

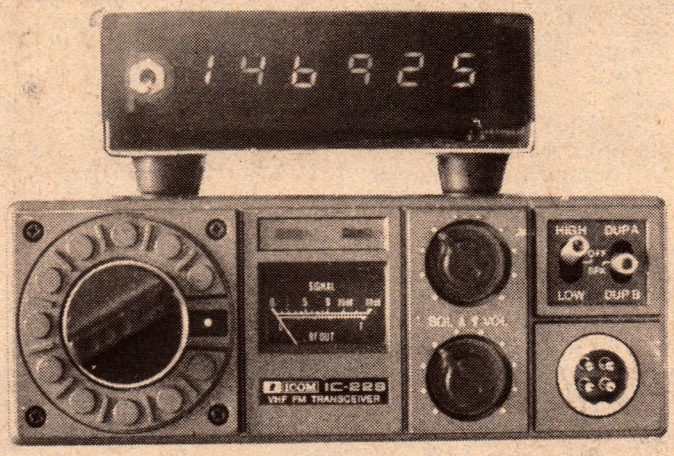
A major problem in developing this project was to minimise modifications, either physical or electrical, to the standard unit. In fact the only thing that has to be done is to solder a number of wires to appropriate locations inside the transceiver. No tracks have to be cut and no other modifications have to be made. Due to the unavailability of the 24-pin socket at the time the project was attempted, we aimed to use the 9-pin socket provided, plus the speaker outlet, ie, eleven connections.

There were too many problems associated with trying to locate the readout inside the set, so it was built in a small external box. This used up 9 of the available connections, leaving only 2 for the scanner. So it was decided to place the scanner inside the unit. It would then need only a couple of leads out for the control switch, which is mounted in the digital readout box.

This system has worked out surprisingly well and has caused no limitations on the device performance, save for the loss of the external speaker output and the discriminator output. If these are wanted the reader may care to use a 24-pin socket.

(Editorial note: A 24-pin socket is now available from Vicom International, 68 Eastern Rd, South Melbourne, Victoria, 3205. A complete set, consisting of plug, socket, and pins, costs $3.90, plus 50c p & P. It is described as "ICOM 24 pin plug".

It will be necessary to construct a small plate to replace that on which the 9-pin socket is mounted, with an opening to suit the 24-pin socket. An alternative socket is the Cannon Type D rectangular. Unfortunately, it is rather more expensive.)



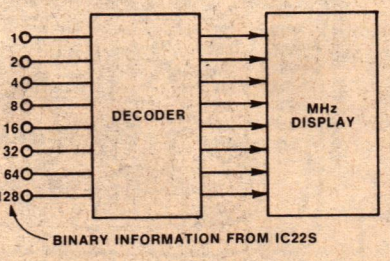


FIG. 1

Fig. 1. The readout system is a decoder which converts binary numbers from the matrix board to a MHz display.

Some of the design constraints placed on the readout were — It should be small so as not to detract from the neat appearance of the IC22S. It should require a minimum of modifications, both physical and electrical to the transceiver and, above all, it should not interfere with normal operation. The frequency of operation should be correctly and unambiguously displayed at all times, including the repeater mode. Cheap, readily available parts should be used to allow a minimum of outlay and bother for the constructor. The unit as described has achieved these aims with very little compromise.

The design is such that the readout always indicates the frequency of operation. For example, on Ch50 the readout will always show 146.500MHz, but for repeater operation on, say, Ch8, the display will read 147.000MHz for receiving and 146.400MHz when transmitting.

All IC's are common 4000 series CMOS. These were chosen to be compatible with the logic in the transceiver, avoiding interface problems and reducing power consumption. Initially a TTL version was built, and performed well, but a lot of circuitry was used inter-

*17 Meadow Rd, New Lambton, NSW 2305.

facing from C-MOS, and the power consumption was in excess of 600mA. The final version draws a nominal 200mA, virtually all by the LED displays.

It should be appreciated that the digital readout is merely a decoder. For a given 8-bit binary word input it produces meaningful symbols on the display to indicate the frequency represented by that 8-bit word. (Fig. 1.) It does not actually count or measure the frequency.

The actual circuit is too complex to provide a detailed explanation of its operation, so a simplified block diagram is presented in Fig. 2, and will be dealt with in some detail. If the reader is interested he can associate the blocks with the actual circuit, Fig. 4, to gain a more exact understanding of its operation.

The connections for the 100s of MHz and 10s of MHz digits are quite straight forward, as these always display a "1" and a "4" respectively ie, segments b and c are lit up on the first display, and segments b, c, f and g are turned on for the second display. These two segments are simply wired permanently in this mode.

(Editorial note: Some commercial digital displays ignore these two digits and simply present the remaining four digits. Such an arrangement may be useful if it is necessary to restrict the display space.)

The next simplest section of the readout is the units of kHz and 10s of kHz digits. Because the IC22S has 25kHz channel spacing only certain numbers need to be produced on these 2 displays. In fact, the 2 least significant bits of the 8-bit binary word give the "number of 25kHz lots" in the frequency selected. (See Fig. 3) The units of kHz takes only the values "0" or "5", and it is entirely dependant upon the first bit value. (1st bit = 1 gives "5", 1st bit = 0 gives "0"). This is sensed by the units of kHz decoder and correctly lights up that display.

BINARY INPUT		LAST TWO DIGITS		
2s	1s	No. OF 25kHz	10s OF kHz	1s OF kHz
0	0	0	0	0
0	1	1	2	5
1	0	2	5	0
1	1	3	7	5

FIG. 3

From the table it is also evident that the 10s of kHz digit takes only four values, ie, 0, 2, 5 or 7. The actual value depends upon both the 1s and 2s inputs of the 8-bit binary word. The 10s of kHz decoder monitors these 2 inputs and produces an appropriate output on its associated display.

Consider now the units of MHz display. As the IC22S is supposed to work only over the range 146-148MHz, the decoder need only be designed to cope with this range. Hence the units of MHz digit is merely required to display a "6" or a "7". Its decoding circuitry

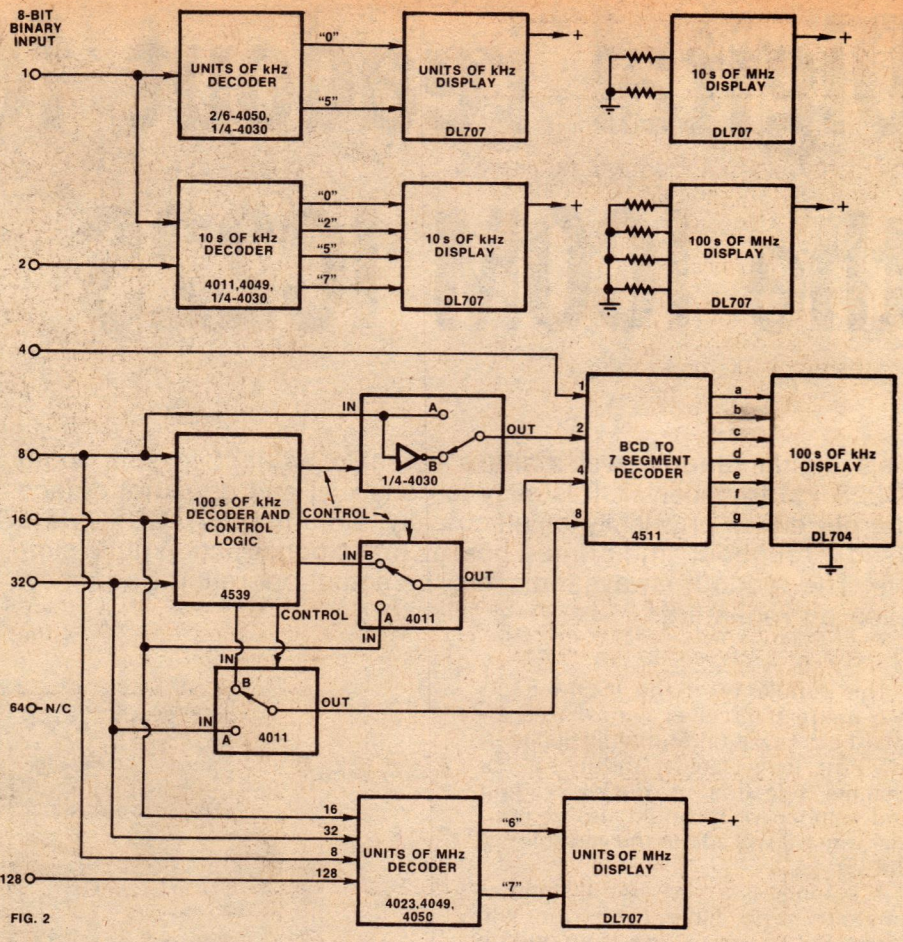
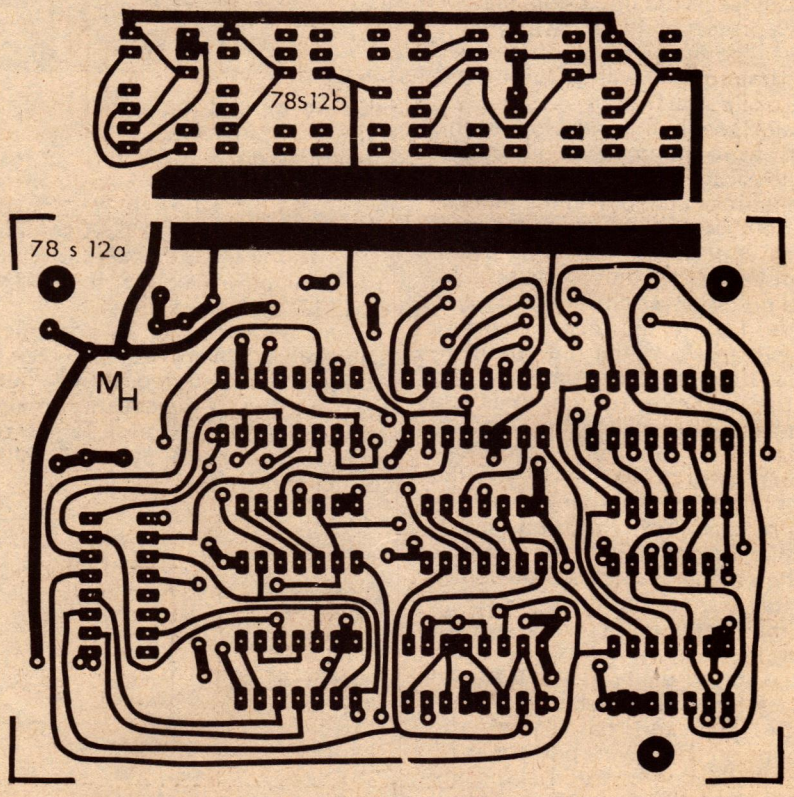


Fig. 2. This block diagram of the readout system should enable the reader to grasp the principles on which it is based. For greater detail refer to the circuit in Fig. 4. The 10s and 100s of MHz are permanently wired.



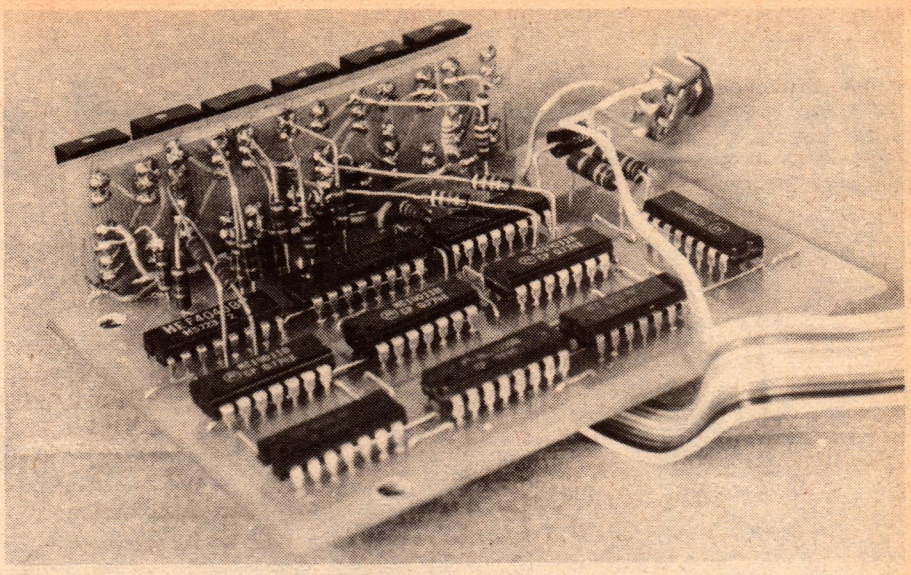
The two board patterns, shown actual size. The smaller one supports the display units and the larger one the decoder proper. The two are soldered together at right angles as explained in the text. A component overlay is shown elsewhere.

IC22S READOUT

senses bits 8, 16, 32 and 128 of the 8 bit input and looks for binary numbers greater than 103. (Binary 01100111, or 146.975MHz.)

On this basis the decoder determines whether to display a "6" or a "7" as appropriate.

Information from this decoder is also used for the 100s of kHz section. When the system is in the range 146.000 to 146.975MHz the four bits 4, 8, 16 and 32 contain the correct BCD code to represent the 100s of KHz. Hence, when a "6" occurs on the units of MHz digit these 4 bits are fed directly to a BCD to 7-segment decoder which turns on appropriate segments on the 100s of kHz display.



Above: Rear view of the decoder and display. Note that the incoming cable connects to the underside of the board.

Below: Fig. 4, the circuit diagram. Having studied the block diagram the reader should be able to follow the more detailed explanation of the circuit. Note that the 100s of kHz readout is a DL704, while all the others are DL707s.

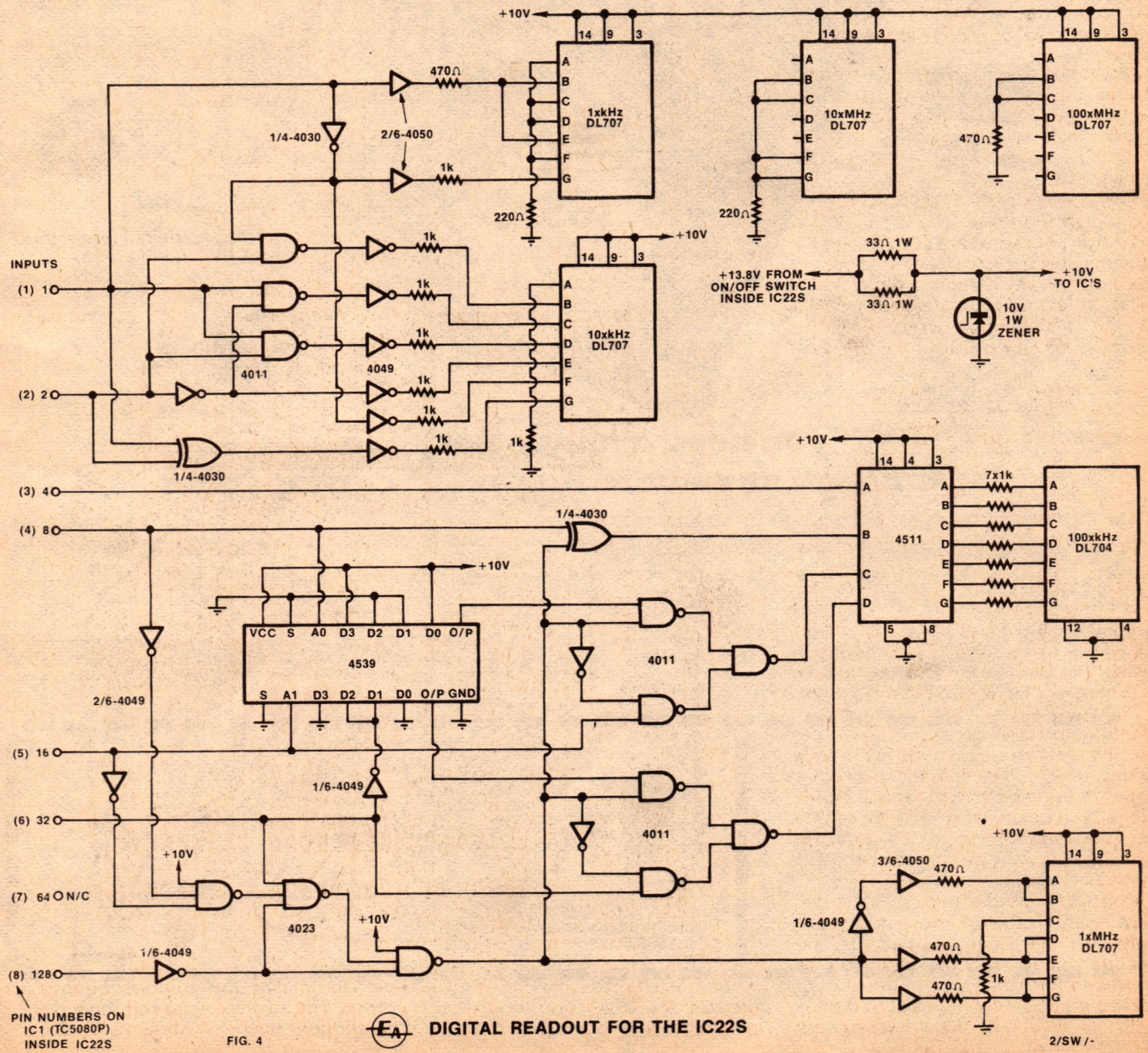


FIG. 4

DIGITAL READOUT FOR THE IC22S

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IC22S READOUT

In the range 147.000 to 147.975 MHz these four bits do not give the correct BCD code, so the information needs to be modified. The least significant bit, bit 4, is still correct and so is left unchanged. It is necessary to invert bit 8, this being done with a programmable inverter in the form of an exclusive -OR gate. Bits 16 and 32 are modified using the technique that any function can be implemented with a multiplexer.

A few comments on the circuit may be in order here. Type 4049 and 4050 gates are used to drive the display segments for the units of kHz, 10s of kHz, and units of MHz digits. These can supply sufficient drive current while in the logical low state only and so need to be used with common anode (C.A.) displays.

Unfortunately, the commonly available BCD to 7-segment decoders in C-MOS, as needed for the 100s of kHz display, require common cathode (C.C.) display units. To save the trouble and expense likely to be caused by specifying a rare and expensive decoder, a C.C. display has been specified for the 100s of kHz digit, driven by the readily available 4511 BCD/7-segment decoder.

This necessitates buying C.C. and C.A. displays which are similar in appearance, such as the DL704 and DL707 series. One drawback is that C.C. displays usually have a right hand decimal point, and C.A. displays have a left hand decimal point. So, by Murphy's law, the only spot where we cannot have a decimal point is where we want it, ie, between the 100s of kHz and the units of MHz digits. Some constructors may be able to obtain both C.C. and C.A. displays with the decimal point on the same side, in which case they can use it, by stringing a 1k resistor from the decimal point pin to +9V for a C.C. or to common for a C.A. display.

If any trouble is experienced in obtaining any of the ICs for this project, they are all available "off the shelf" at Radio Despatch Service. Our thanks is extended to Goeff Wood of that firm for his time and effort in checking this fact.

Construction of the digital readout is quite straight forward if printed boards are used, as is recommended. By simply following the component overlay no problems should be encountered, but a few pointers may help.

There are 30 links on the main board. This may seem excessive, (early prototypes were on double-sided boards), but it was decided that it would be easier and cheaper for the home constructor to use a single sided board. (Unless you have a plated-through-holes board, double sided involves more time and effort anyway!)

All 30 links should be fitted first, as some are underneath ICs. Then the 10 ICs can be correctly located and oriented before soldering in. Sockets can be used if preferred, but are not necessary provided due care is taken. The two 33 ohm resistors and zener may now be put on the board, along with the 470 ohm and 1k resistors for the units of kHz display.

Set the main board aside and install the six 7-segment readouts on the display board. Note that the common cathode display should be inserted third from the right looking from the front. Try to keep all displays square and level with each other.

The display board is soldered at right angles to the main board. The overlap at the bottom should be only sufficient to run a fillet of solder (1.5mm) so that

PARTS LIST

SEMICONDUCTORS.

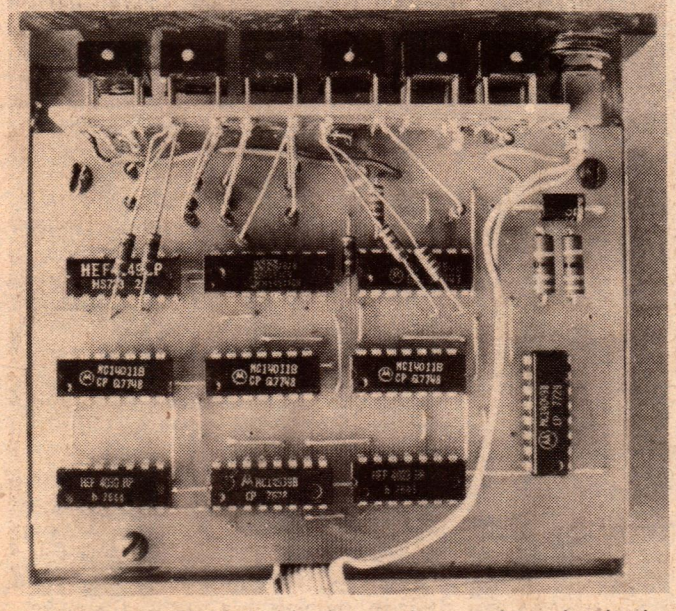
- *3 4011 4-two input NAND gates.*
- *1 4023 Triple-3 input NAND gates.*
- *1 4030 Quad exclusive-OR gate.*
- *2 4049 Buffer inverter.*
- *1 4050 Buffer non-inverter.*
- *1 4511 BCD to 7-segment decoder.*
- *1 4539 Dual 4 to 1 multiplexer.*
- *5 DL707 Common anode 7 seg. displays or similar.*
- *1 DL704 Common cathode 7 seg. display or similar.*
- *1 10 Volt 1 Watt zener diode. (eg, BZX 70 C10)*

RESISTORS

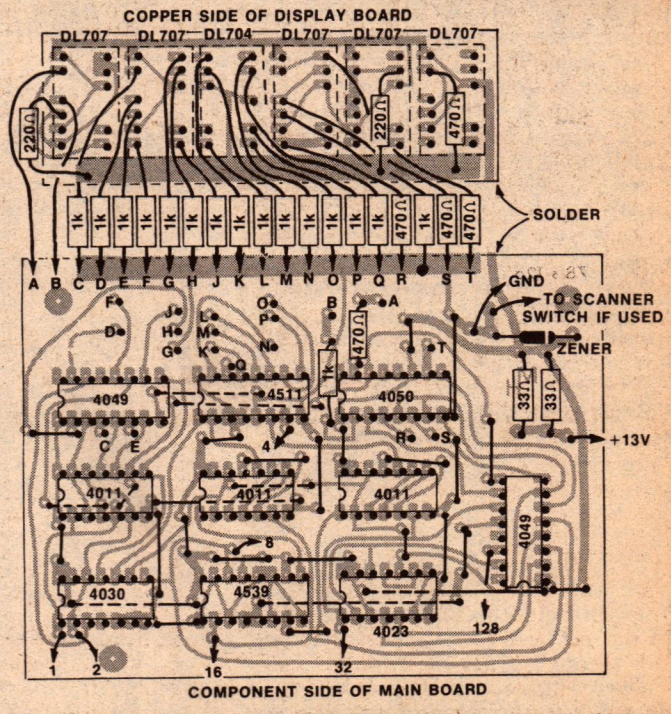
16 1k	*¼W*	*2 220*	*½W*
5 470	*¼W*	*2 33*	*1W*

MISCELLANEOUS

- *1 9 pin plug* — *Supplied with*
- *1 3.5mm plug* — *the IC22S*
- *Suitable Case (See text) 105 x 95 x 32mm*
- *60cm rainbow cable, hook-up wire, etc.*
- *1 Piece red Perspex (105 x 32mm)*
- *4 Rubber feet.*
- *1 Main printed board. 78/S/12a*
- *1 Display printed board. 78/S/12b*
- *3 Spacers and screws to suit.*
- *Solder.*



Another view of the finished unit, showing how the display units are mounted. With the picture on the previous page it shows the logical placement of the resistors.



Overlay diagram showing location and connection of components, as seen from the components side. Compare with the photographs on this and the previous page.

some copper is available above the main board where a resistor will be soldered later. (Fig. 5.)

Ensure that the boards are correctly aligned so that the positive lead to the display board can be fillet soldered also. Using the overlay, the remaining resistors can be soldered between the main board and the display. Start with those connecting to the lowest pins on the display and work upwards. The pictures should make this clear.

Nine leads need to be connected to the unit; +13V, chassis, and seven signal leads. Their location should be evident from the overlay. The author found it easier and neater to solder these leads on the back of the board, but the constructor can please himself. The other end of the seven signal leads go to pins 1-7 of the 9-pin plug supplied with the IC22S. These can be conveniently run in rainbow cable. The supply pins go to a 3.5mm plug (positive to centre) which will plug into the extension speaker outlet.

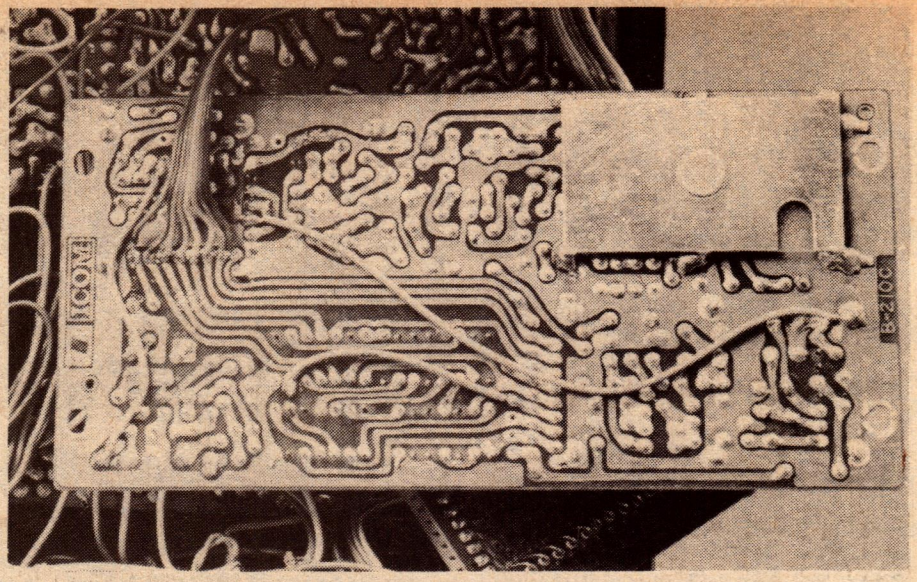
As no suitable box was available one was made from 22 gauge aluminium. It consists of two U-shaped sections and measures 105 x 95 x 32mm. A piece of red perspex was cemented in position to form the front of the box, and threaded plastic spacers were used to mount the board. The constructor can please himself how he mounts the unit or what type of box he buys or builds. Although it hasn't yet been tried, the use of suction cups as feet would enable the readout to be attached to the set for mobile use, or perhaps strong magnets could be tried.

This completes construction of the readout proper. It is now necessary to make various connections inside the 22S and bring them to the 9-pin and external speaker sockets.

Remove the yellow speaker lead and small capacitor from the external speaker socket, "mid-air" terminate them, and tape the connection. Now connect a wire to the socket and run it to the "High-Off-Low" switch on the front panel. Solder the lead to the top left contact of this switch. (Fig. 6) Do not remove any leads from the switch. This connection provides power to the readout when the set is turned on.

To connect the other leads the synthesizer board needs to be lifted. It is the smaller of the two boards in the IC22S, the one facing the bottom of the set. Carefully solder an 8 lead rainbow cable to pins 1 to 8 on IC1, the TC5080P. These are the 8 pins on the farthest side of the IC from the back of the radio. (see photo and Fig. 7).

These leads are run to the corresponding pin numbers on the 9-pin socket on the back panel, with one exception. The lead from pin 7 of the IC is not terminated on the socket, but rather the lead from pin 8 of IC1 goes to pin 7 of the socket. The lead from pin 7 is not used for the readout, but will be required if a scanner is built. For the present, tape it up. Note that the discriminator lead and the capacitor need to be removed from the 9-pin socket and mid-air terminated. Also the chassis connection to the socket needs to be removed.



Underside view of the synthesiser board showing the rainbow cable (top left) which connects to pins 1 to 8 of the TC5080P (IC1). Refer to Fig. 7 at the bottom of the page for further details of the location and pin numbers of IC1.

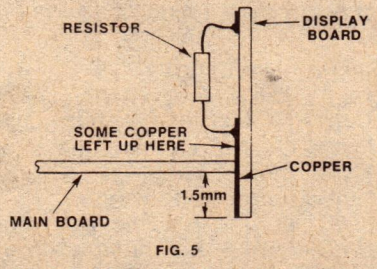


FIG. 5

Fig. 5. Details drawing showing how the main board and the display board are soldered together.

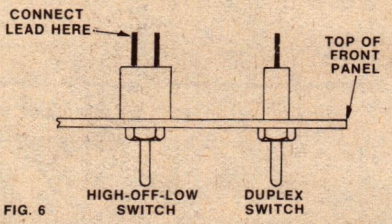


FIG. 6

Fig. 6. Power for the readout circuit is taken from the power switch on the front of the IC22S, as shown here.

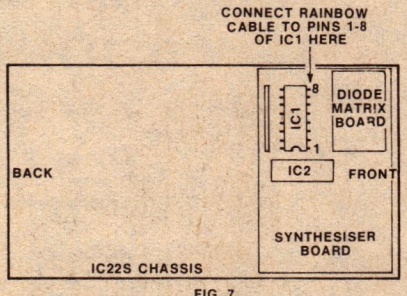


FIG. 7

Fig. 7. Location of IC1 on the 22S synthesiser board, and its pins 1 to 8 which are wired to the rainbow cable.

The IC22S can be operated without the readout, say for mobile or portable work by simply unplugging the readout. Remember that the readout is only correct for frequencies between 146-148MHz. If you have channels outside this range the display will not be correct, and sometimes the 100s of kHz digit may turn off. This is normal if an invalid frequency is presented, eg, on channels with no diodes programmed, the readout will indicate 146.000MHz although the actual frequency is 144.4MHz.

And that is about all that needs to be said about our digital readout. Whether you intend to build a scanner or not, the readout is a very useful device in its own right, giving the IC22S user the best of both worlds; the convenience of pre-programmed channels together with a direct frequency readout.

In a later issue we hope to describe the scanner system to go with the readout.

This scanner has several attractive features, including fast (two seconds) and slow scan from 146MHz to 148MHz in 25kHz steps; automatic stop for a signal, with the option of manual hold or automatic re-scan; and protection against accidental transmission while in the scan mode. And this is in addition to the normal 22 pre-selected channels.

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THE VIDEO TRAUMA

Perhaps most obvious has been the use of television receivers for the playing of video or television games. These games which utilised dedicated chips, often caused family frictions during prime time viewing hours as siblings fought to secure the use of the monitor either as a VDU (visual display unit) for game use, or to watch a desired programme on the favourite channel.

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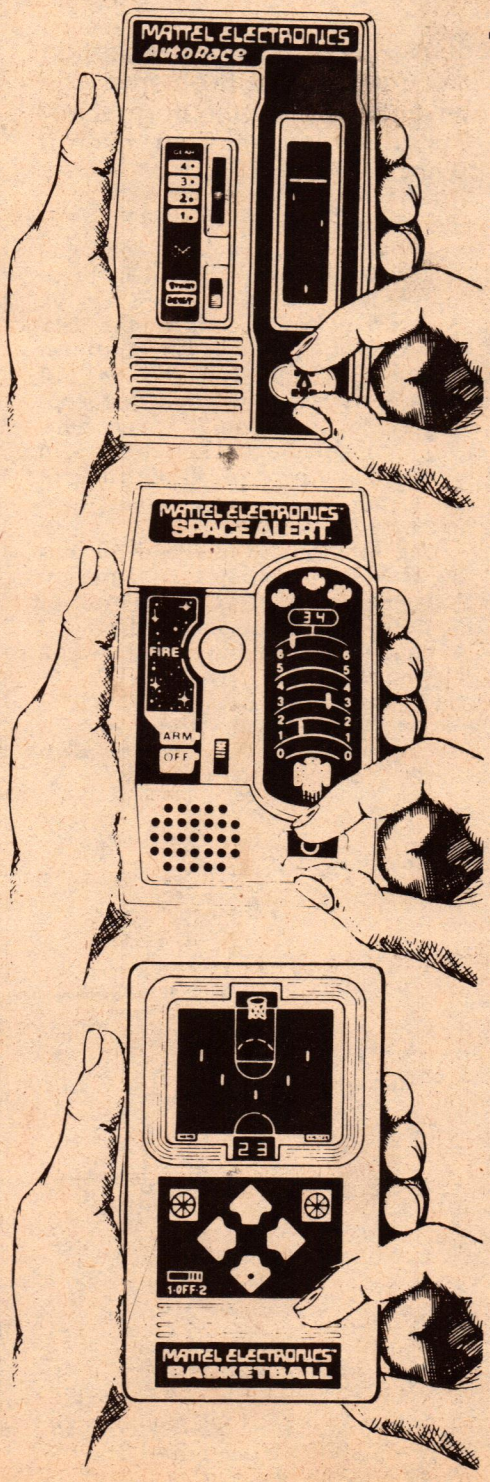

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The Serviceman

An 'impossible' TV site — unusual approach pays off

This story of how a stubborn colleague solved a sticky TV reception problem may inspire others who encounter similar problems. The moral is not to be hidebound by convention: when the normal approaches fail, don't be afraid to try something different, even if everyone else insists that it won't work.

"Gold is where you find it" was a popular adage in Australia's gold rush days, and was not quite the pointless statement it may appear superficially. It was a succinct way of conveying the thought that the "rules" governing the likely presence of the precious metal were not infallible; that it was likely to be found anywhere and, therefore, it was worth looking anywhere. So, it was "where you found it".

I understand that a similar philosophy existed in the United States during the early days of oil exploration, particularly by the "wildcat" drillers. Considering that many of the so-called "rules", as applied to both commodities, were based as much, or more, on superstition than geology, it is not surprising that many people ignored them, and dug, or drilled, where instinct told them — often successfully.

And what has all this to do with servicing? Well, it provides what I think is a very useful parallel to the story I am about to tell. A story in which another precious commodity (by today's standards) is involved — TV signals in fringe areas.

In the early days of TV, at trade lectures staged to introduce the subject, speakers with overseas experience sought to pass this on for our benefit.

And one of the points I remember being raised concerned "difficult" TV areas, particularly land-locked ones. This was the possibility of obtaining a useful signal by reflection from a hill or cliff, rather than by the nominally direct path.

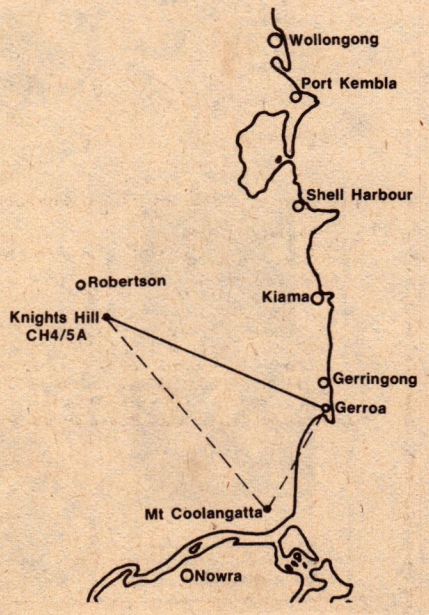
As I recall, all the speakers were unanimous. None of them had ever seen this done successfully and, as far as they were concerned, there just wasn't any point in trying it.

Unforunately, I feat that a lot of us took their statements rather too literally; we rejected the idea completely from then on. As it happened, my own stamping ground provided little need for such thoughts, so it was of academic interest only.

But not so in the case of a colleague — whom I have mentioned in these notes before — whose business is in the area south of Wollongong, on the NSW south coast, about 80km south of Sydney. This area can provide just about every hazard to good TV reception one can nominate. It is very hilly, with innumerable pockets tucked in behind hills where by all the rules of the game, no TV signal could ever penetrate.

Long distances are also involved, plus the problem of salt air contamination along the coastal strip where most of the population is concentrated. So, if it isn't one thing it's another, and never a dull moment!

It was against this background that he told me the following story, which is best related in more or less his own words:



The solid line shows the direct path which should have been used, and the dotted line the one that was used.

It all started with a telephone call from a long-time friend in the "big smoke" (Sydney). It seemed that he had a friend who had bought a house somewhere on the south coast — and which he therefore automatically assumed would be in my territory — and which he was using as a weekend and holiday cottage at present. It was to become his retirement home in a couple of years.

The only snag was that there seemed to be no way that he could get any TV programs. Quizzed by my friend he agreed that he had sought advice from several local TV organisations, and a TV aerial installation company. Between them they had erected a number of test aerials, made measurements, looked at the pictures, and shaken their collective heads.

There were two practical problems as I saw it. One was that, if everyone else had failed, what chance did I have? The other was that it was a lot further from my base than I normally work. As a result I might travel a long way only to find that I could do no more than those before me. But, to keep faith with my friend, I said I would try to fit in a visit the next time business took me in that direction.

In the meantime, I did a bit of research, mainly by asking questions of other blokes who lived closer to, and worked in, the area. And that didn't help much either. Oh, they were helpful enough, but their description of the area, TV signal-wise, was mostly unprintable.

If I'd been less than keen before, it had been enthusiasm compared with how I felt now.

A couple of days later my friend's friend was on the 'phone. As I had already gathered, it was a story of one failure after another and, combined with my own research, seemed to add up to a hopeless cause.

In spite of this the customer almost begged me to come and have a look at the problem, adding that he felt sure I could do something about it. Which was very flattering, but it didn't help my confidence any. Nevertheless, I arranged to call in sometime the following week, when I planned to be near the area.

When I finally pulled up outside his house about 10 days later I could see why he was in strife. For those who know the area, it was just south of Gerringong, right on the water's edge, and about 16 miles from the transmitters on Knight's Hill to the north-west.

But it might just as well have been 116 miles, for all that the distance mattered. The place was hard in under a steep hill, probably 150ft high, directly between it and the transmitters. I reckoned there was no way I was going to get signals through that heap of dirt.

The irony of the situation also struck me. In all other respects it was a most delightful spot. A typical quiet seaside setting, with a relaxed atmosphere, ideal for retirement and, from the lounge room, offering a magnificent view of the coastline down to Jervis Bay. But no TV. It was easy to see why he bought it, although it's not a bad idea to check out the TV scene before signing on the dotted line.

But that was history, and I was expected to do something practical here and now. But first there was the inevitable "cuppa tea" and informal chat before getting down to business. While we chatted, the customer turned on the TV set and demonstrated what he was getting at present. And was it crook!

Totally unviewable would be the best description. Granted, there was a locked picture, but it was buried under tons of snow. But worse than this was the ghosting, which was "gross" by any standards.

Admittedly, the existing aerial arrangement was primitive, being all that was left after the previous attempts. But the customer assured me that it was about as good as any arrangement tried so far.

I had two modest antennas in the van; both combined 4/5A arrays whose performance I know well. Even if they weren't good enough, I know them well enough to know whether something larger was worth considering.

One, which has marginally less gain than the other, is a Channel Master "Colour-Ray". While its gain is modest, it has an excellent front-to-back ratio and minimum side lobes. Assuming I could rake up a strong signal, something like this might just solve the ghost problem.

But first I wanted to see what signal strength was available, without worrying too much about the ghosts. I fitted the higher gain antenna to a length of pipe from the van, attached a length of ribbon, and connected this to the trusty field strength meter.

Thus equipped I wandered around the yard looking for likely signal spots. About the best signal was around 50*u*V or less, which is not really worth considering. Something like 200*u*V is really needed for a good picture.

Then I hopped up on the roof and

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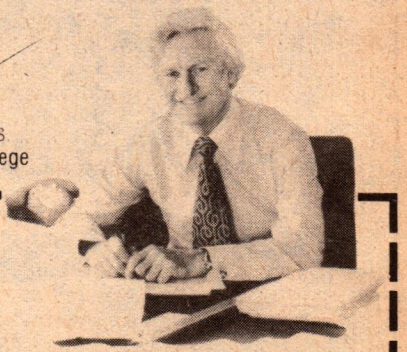

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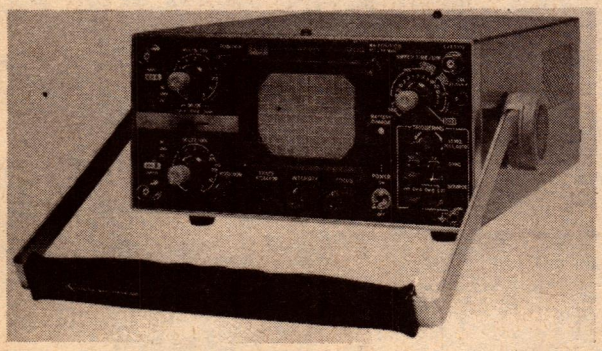

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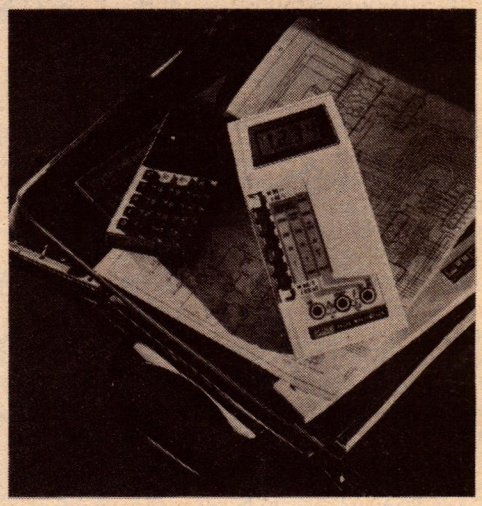

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did a balancing act while waving the aerial above my head. Still no joy. At the other extreme I tried working only a few feet above ground level, since I have found quite strong signals near ground level when working behind hills. (Don't ask me why.) But, alas still nothing worthwhile.

In desperation I tried another idea. Sometimes a signal will find its way around a hill, rather than over it, so I pointed the antenna to one side of the hill. This didn't seem to help much but then, almost by accident, I swung it through about 90°. Suddenly the poor old meter needle was bashing itself against the stop.

More specifically, the signals were now running at several hundred microvolts, with every indication that they were bouncing off a large hill, Mt Coolangatta (also known as Berry Mountain) about eight miles away to the south-west.

My first reaction was that these reflections accounted for the dreadful ghosts, but then I began to wonder whether they might be useful as primary signals. It seems a crazy idea, and against all the "rules", but what did I have to lose?

At this point another "cuppa" appeared on the scene, and it was very welcome. I kept on thinking about the idea while we relaxed over the tea, and the more I thought about it the more it seemed worth trying.

Refreshed by the "cuppa" I replaced the field strength meter with a monochrome portable set I carry for this kind of work. Looking towards the transmitter, straight into the hill, I was able to find a spot where ghosting was quite low, but in all cases the signal was far too weak.

Moving around to the south-west, looking at Mt Coolangatta, produced an opposite effect; a very strong, virtually snow-free signal but with significant ghosting. This wasn't altogether surprising, and I had at least proved that there was plenty of signal available, if only I could clean it up.

I suspected that the major ghosting was being created by the direct signal which was now coming in on the side of the aerial. If I was correct there was a chance that the lower gain Channel Master aerial, with its minimum side lobes, might be able to reject this signal, while still delivering enough output from the reflected signal.

I swapped antennas and tried again. The result was far better that I had dared hope for; still snow-free but with the ghosts very much reduced. We seemed to be getting somewhere at last. But I reckoned it was worthwhile trying to do better and, with the customer looking over my shoulder — after all he was the one who had to live with the picture — I began searching for a spot which might have even lower ghosting.

What's more I eventually found one. It wasn't easy, because many spots which seemed promising suffered from other problems. The most obvious was lower signal and more snow, but there was also a sound problem. The multi-path transmissions introduced quite severe distortion in some aerial locations. Fortunately, I found a spot where both snow and ghosts were at a minimum, and the sound was clean.

At this point another decision had to be made. The customer had indicated that he was interested mainly in the national transmitter on channel 5A, and all the tests had been made on this channel. But what of the commercial station on channel 4? One would have to be very lucky to find that a set-up like this would be identical for both channels, and I don't have that kind of luck.

Also, I had to be a bit diplomatic. Since the customer had indicated that he had little interest in channel 4, it might be hard to justify charging him for additional time spent looking for a good spot — particularly if I didn't find one! But I wanted to know what was possible for my own benefit. So I made it clear that this exercise was on the house.

As expected, the 5A set-up was useless for channel 4. But simply rotating the antenna through about 45° until it was only about 45° off the line to the transmitter, produced a first class picture; substantially better than that from 5A. There was quite adequate strength, and almost no ghosting at all.

So I put it to the customer that, for the price of a second antenna, he could have both channels. Strangely, he wasn't interested, being quite happy to view 5A exclusively. Well, it was his decision, and not my place to argue.

Accordingly, I fitted a "J" bracket on the bargeboard at the chosen spot, supporting a short mast and the Channel Master antenna, carefully orientated. And with the installation only a few feet from the ocean, coax cable was regarded as essential.

Then we sat back in the lounge room admiring the picture and — yes — enjoying yet another "cuppa". But I reckoned I'd earned it.

And that is my friend's story. I think most readers will appreciate the parallel between it and those of the gold and oil seekers.

The moral is obvious; don't be afraid to break the rules when all else fails. This is the more so because we have the edge on the miners: they had to spend a lot of money digging holes, deep ones sometimes, whereas all we have to do is point the antenna the other way. As this story proves, it can work!

Like the man said, "gold or oil (or TV signals) are where you find them."

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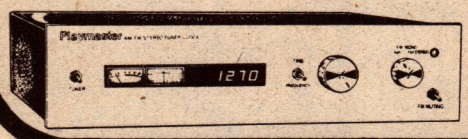

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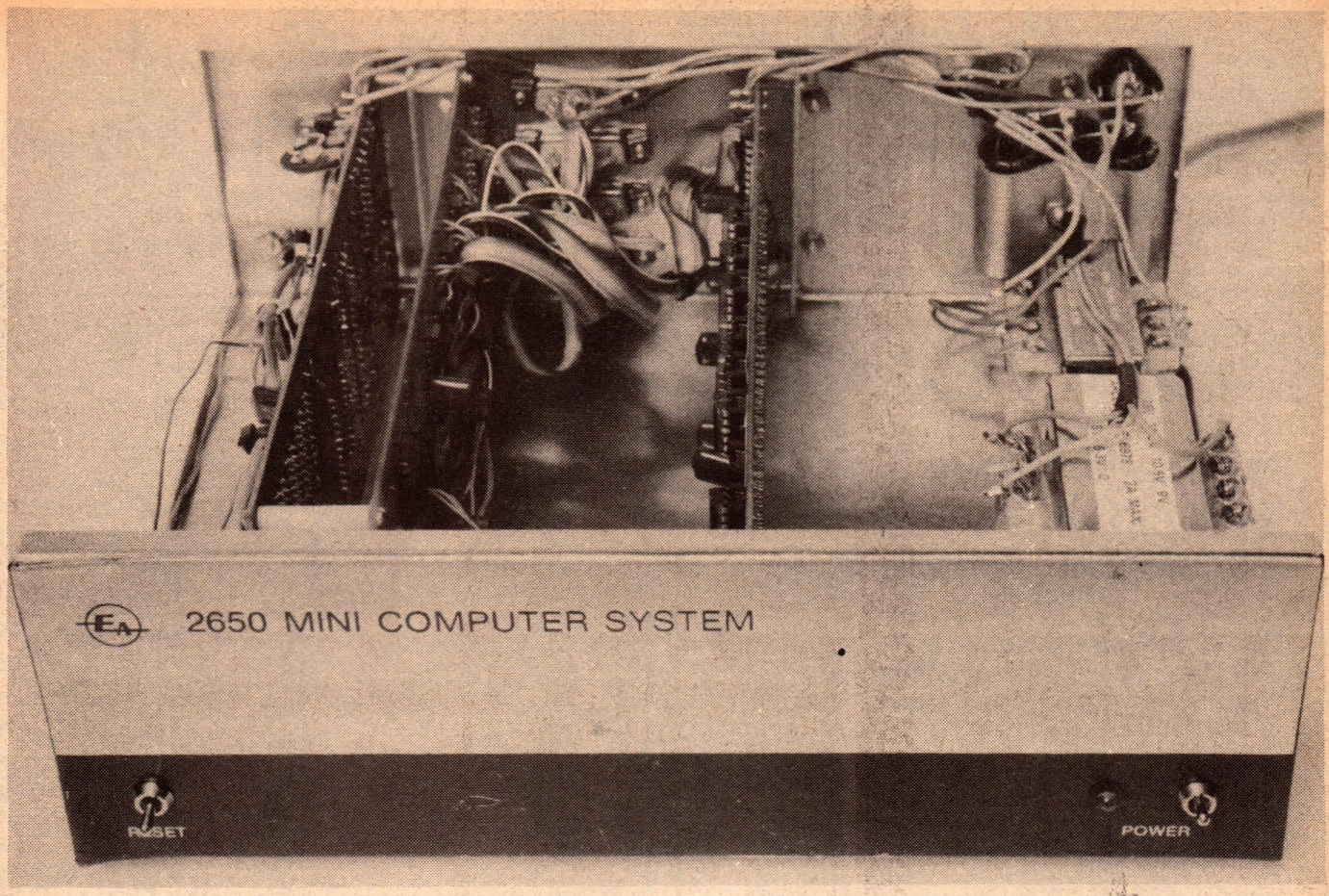

Extra RAM for the 2650

In this second article giving expansion details for the 2650 Mini Computer System, we give details of an 8K RAM board based on 2114 static RAM chips. Optional address and data buffering is provided, as well as full address decoding.

by DAVID EDWARDS

The 2114 static RAM chip, which forms the heart of the memory system, is only a relatively new device. These are 4096-bit devices, organised as 1024 4-bit words. Access time is 650ns or better, and all inputs and outputs are TTL compatible. They are packaged in 18-pin DIL form, and require only a single 5V supply.

Specified maximum power supply current is 100mA, with typical devices drawing about 80mA. This implies an 8K array would require a supply current in the vicinity of 1.5A, and that the dissipation in the RAMs would be about 7.5 watts.

The new board described in this article holds a maximum of 16 2114 chips, as well as five buffer and housekeeping chips. It is intended primarily for use with 2650-based systems, but can be adapted for use with other microprocessors. Optional address and data buffers have been provided, as well as on-board address decoding.

Turning now to the circuit diagram, we can discuss the circuit in more detail. The optional data buffer is provided by two 81LS95 octal Tri-state buffers, wired as a bi-directional buffer. The direction of the buffer is controlled by the read/write line.

Low cost 74LS04 hex inverters are used as the address buffers, with two spare inverters used to buffer the read/write line. These inverters also provide the required control signals for the data buffer.

The RAMs are connected in pairs to form 1K blocks, with half of the data lines going to each chip. The two chip enable lines for each pair are connected together, giving a total of eight active-low chip enables.

These are controlled by the 74LS138 decoder, which decodes address lines 10, 11 and 12. The 74LS138 is gated on and off by the page select signal and the buffered operation request (BOPREQ) signal. The page select line is generated on the expansion board, and is derived from address lines AD13 and AD14. It is also used to disable the data buffer when the page concerned is not selected.

The buffers on the expansion board described in the October 1978 issue are capable of driving at least one of these RAM boards without the use of the additional buffers. In this case, all that is required to support the RAM chips is the 74LS138 decoder.

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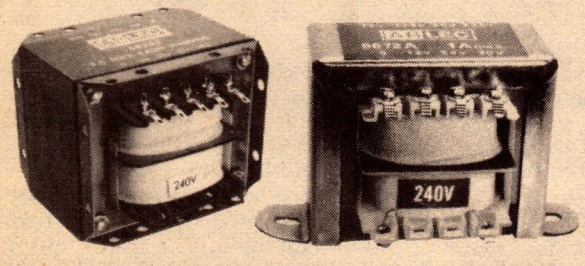

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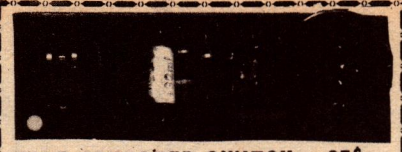

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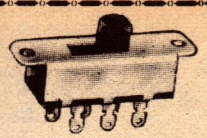

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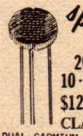

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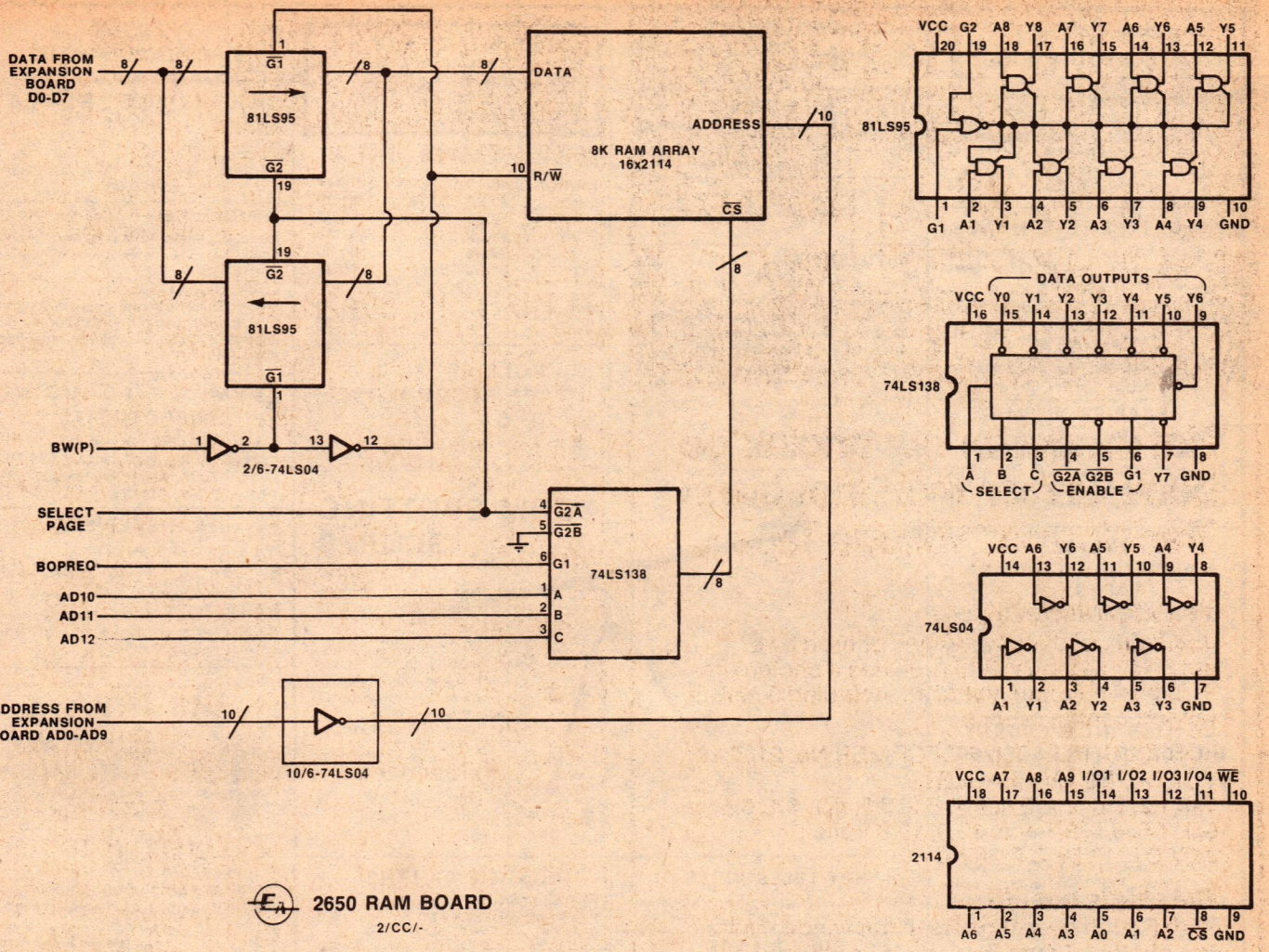


more than the data lines (each data line connects to 8 2114s only, while the address lines connect to all 16), and since the cost of two 74LS04s is negligible compared to the RAM cost, it is probably worthwhile buffering the address lines.

On economic grounds, the extra cost of the data buffers can probably be justified also. Use of the buffers has the advantage that the system access time is not degraded by the extra bus capacitance that otherwise occurs.

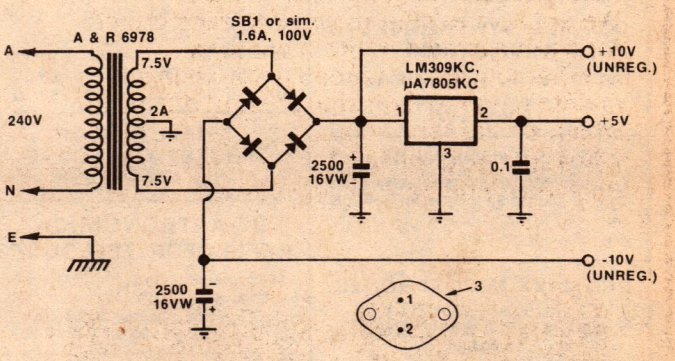
Note that we have not specified in either the circuit diagram or the PCB overlay diagram the order in which the data lines and the ten lowest address lines should be connected. This is because it is immaterial which way they are connected.

All that is important is that each address should define a unique memory location, so that data is not lost or destroyed when reads and writes are performed. It is for this reason also that the logic inversion occuring in the address buffer is allowed. All the inversion does is shuffle the actual RAM storage locations about, without actually losing any of them.

It is important, however, that AD10, AD11 and AD12 be connected in the correct order, so that the memory chips

ABOVE: This is the complete circuit diagram of the new RAM board. The address and data buffers are optional.

RIGHT: The suggested power supply shown here is adequate to supply a single, fully populated RAM board.



can be fitted in pairs. This allows the memory to be filled in increments of 1K, so that the cost of the RAM chips can be spread over time.

Before discussing the constructional details, let us first return to the power supply requirements. The maximum theoretical current requirement for a fully populated board is 16 x 100mA + 2 x 26mA (81LS95) + 2 x 4 5mA (74LS04) + 11mA (74LS138) = 1673mA. Obviously, if it is intended to run several RAM boards, the best approach is to use an external 5V supply, such as the Minibrute described in the November 1977 issue.

If only one RAM board is to be driven, things become a little more difficult, however. The maximum current required is in excess of that which can be obtained from a single three terminal regulator. However, in practical cases, the actual current will be somewhat less than this.

If fact, the measured current consumption of the prototype board, fitted with full buffering and 14 2114 chips was only 720mA. So use of a standard three-terminal regulator should be possible in most practical cases.

The suggested power supply we have shown is based on the use of a TO-3 encapsulated three terminal regulator, on the basis that heatsinking of these

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1½" diam. 4½" F.L. **75c.** 2½" diam 2" F.L. **$1.50** each or **$2.50** per pair. P&P 80c

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devices is easier. In our particular case, construction was also simplified.

We used an additional 15V 2A transformer and an encapsulated bridge rectifier, along with two 2500uF 16VW electrolytic capacitors. The bridge rectifier is not strictly required, as the centre tap of the transformer is earhted. However, it allows a negative supply rail to be developed, and this can be used to power devices attached to the non-extended I/O ports, as detailed in the October 1978 issue.

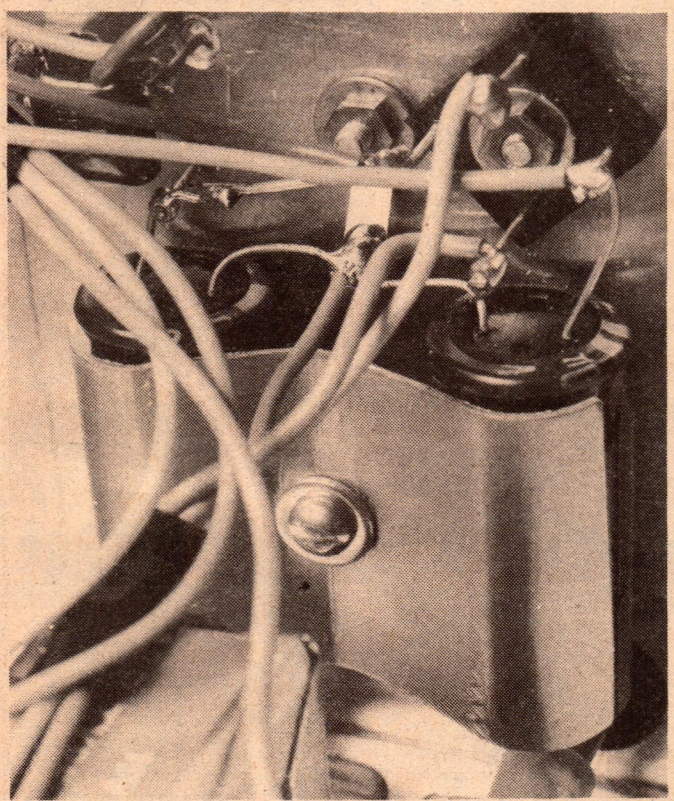
A second advantage of the encapsulated bridge is that it simplifies the mounting arrangements, as it can be bolted directly to the chassis. As you can see in the photographs, we mounted the additional transformer between the front panel and the original transformer.

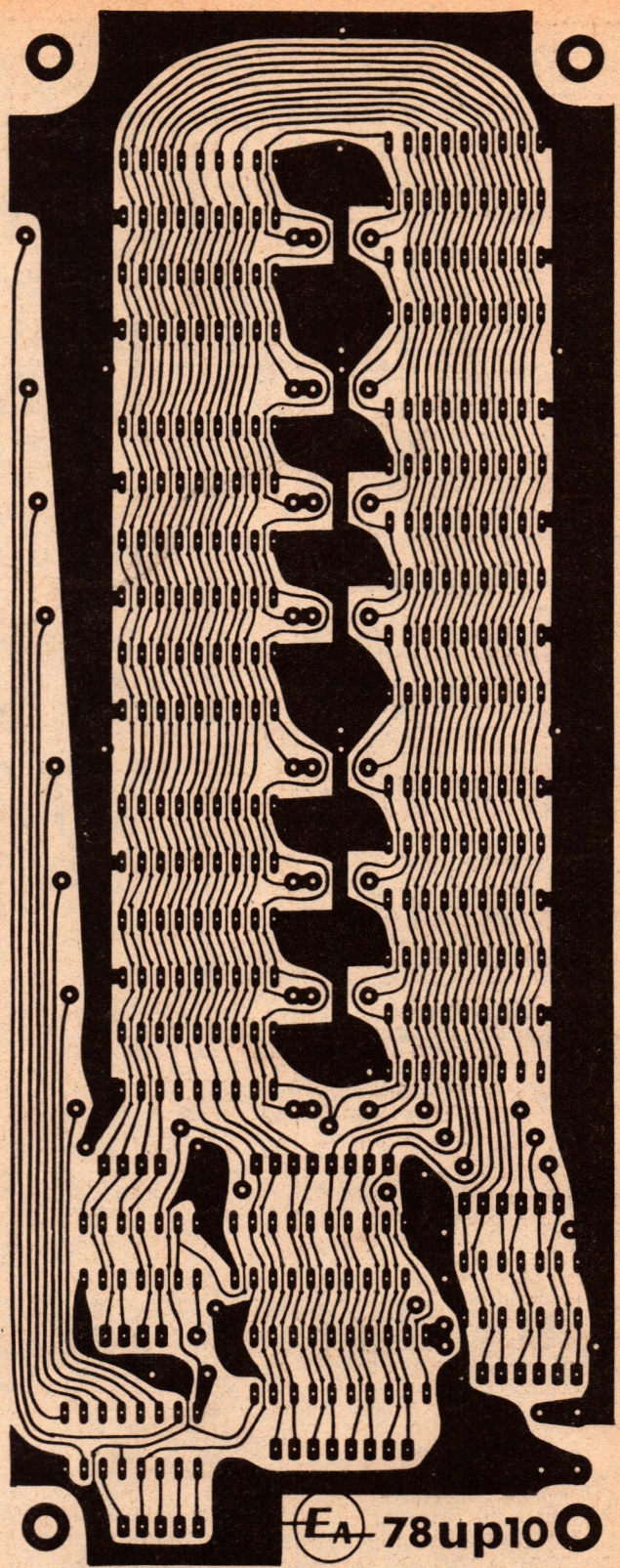
The capacitors are clamped to the bottom right hand corner of the back panel (use PC mounting tupes), with the bridge and regulator mounted above them. The wiring can be completed by suitably bending the component leads. Use solder lugs for the chassis connections to the regulator.

Construction of the RAM board should be quite easy. The PCB is coded 78up10, and measures 218 x 81mm.

Fit all the links first, and then the RAM stockets. We recommend sockets for the 2114s as this allows them to be removed easily, or added in stages. Then fit the bypass capacitors, and finally the TTL ICs. Sockets are not required for these.

At the right is a full size reproduction of the PCB pattern, which may be copied or traced. Commercial PCBs should be available in due course. Use the photograph below as a guide while wiring the power supply.



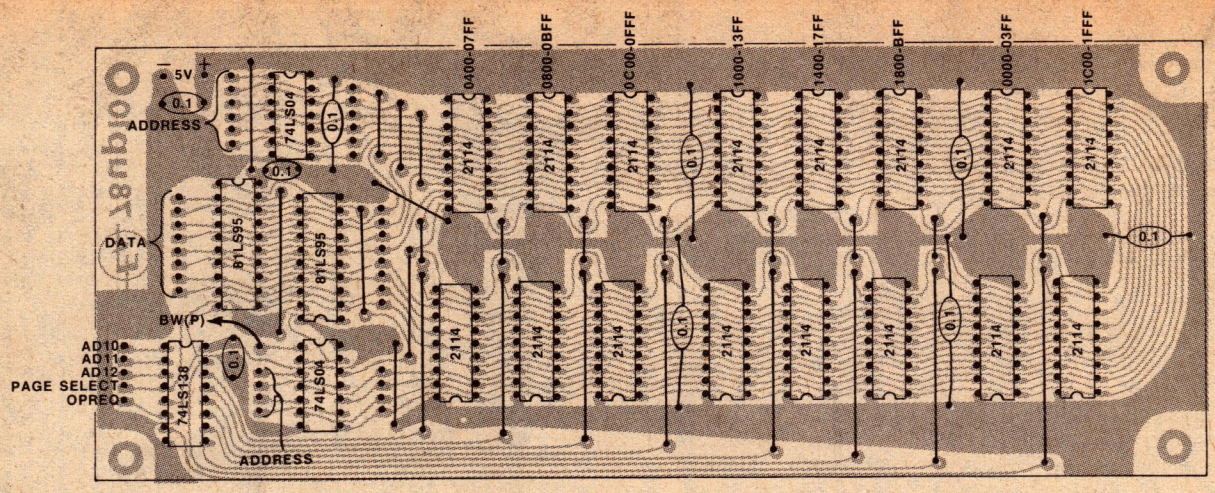


When the board is complete, check it carefully for solder bridges and dry joints. The next step is to complete the connections between the RAM board and the expansion board. There are two different configurations which can be achieved, however.

If you wish to maximise the amount of RAM, this can best be achieved by making the new RAM board page 1 of the memory. This will then allow at least 3K of RAM to be retained on the main CPU board. It does mean, however, that the memory will not be continuous, as page 0 cannot then be completely filled with memory.

If continuous memory is desired, then the best approach is to remove all RAM from the CPU board, and make the new RAM board exist at page 0. In order to retain Pipbug, it will then be necessary to leave 1K of RAM vacant at locations 0000 to 03FF.

In order to prevent bus conflicts, it will then be necessary to disable the data buffer on the expansion board only when Pipbug is selected, rather than when page 0 is selected. This can be achieved by connecting the chip enable signal for Pipbug to the buffer,



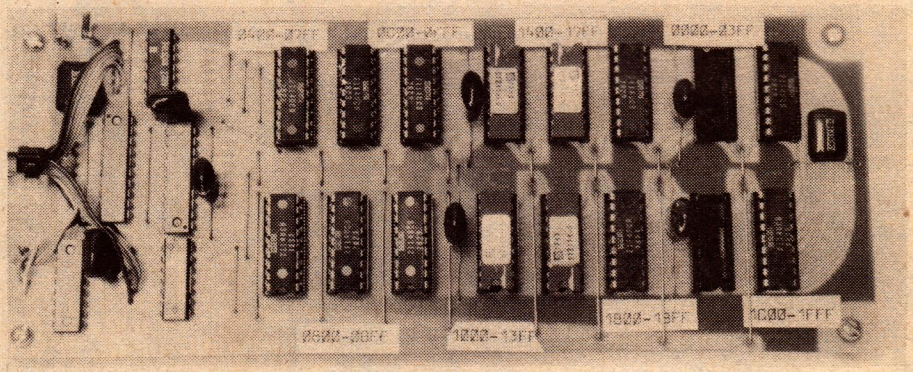
ABOVE: Use this overlay diagram both to assemble the components onto the PCB, and to find particular 1K memory blocks.

BELOW: As you can see in this photograph, we actually labelled the RAM blocks with their addresses.

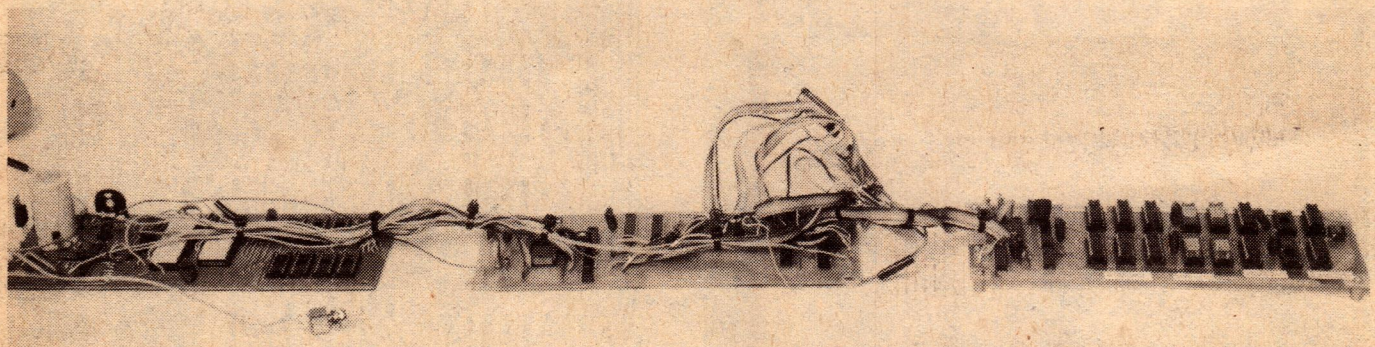
Parts List

16 2114 static RAM chips
1 74LS138 one-of-eight decoder
9 0.1uF polyester capacitors
1 PCB, coded 78up10, 218 x 81mm

OPTIONAL PARTS REQUIRED FOR BUFFERING
2 81LS95 octal Tri-state buffers
2 74LS04 hex inverters
Solder, tinned copper wire, rainbow cable, mounting hardware, PCB pins
NOTE: Resistor wattage ratings and capacitor voltage ratings are those used for our prototype. Components with higher ratings may generally be used provided they are physically compatible.



BELOW: The way in which the three PCBs can be removed from the case for servicing and the way in which the cables between them are arranged can be seen in this view.



rather than the page 0 select signal. This can be done by opening the link on the expansion board, and running a wire from the 0 output of the 74LS138 on the CPU board to the opened link.

In all other respects, wiring of the RAM board is identical for both cases, and is quite straight forward. Simply connect the appropriate control, data and address leads between the expansion board and the RAM board. If you do not use the address and data buffers, use the second set of address and data inputs.

Once construction is complete, test the board before inserting the 2114s. Do this by applying power, while monitoring the supply rails. If they do not rise immediately to 5V, switch off and trace and rectify the fault. Once all is correct, plug in one pair of 2114s, and switch on, again monitoring the supply rail.

Test the RAM, and the address and data bus buffers, if fitted, by loading and running a small program from this area of RAM. Assuming all is OK, you can insert the remaining 2114s. These can be likewise tested by running programs known to be OK.

2114 RAM chips are available from Radio Despatch Service, of 869 George Street, Sydney, Dick Smith stores, Applied Technology of 109 Hunter Street Hornsby NSW, and from Pennywise Peripherals, of 19 Suemar Street, Mulgrave Victoria.

Please note that under normal conditions, the 2114 chips do dissipate significant amounts of heat, and become warm to the touch. For this reason, it is advisable to operate the unit in a well ventilated environment, to reduce the overall temperature rise of the case.

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10 555 for	$2.80
10 741 for	$2.80
5 7490 for	$3.00
5 7400 for	$1.00
5 4001 for	$1.00
5 4011 for	$1.00
2 7805 for	$1.90
2 7447 for	$2.00
2 7448 for	$2.00

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XLP-3-31	$3.25
XLP-3-32	$3.00
XLR-LNE-11c	$3.05
XLR-LNE-32	$4.30

DIODES

1N4148	4c
1N4002 1A 100V	7c
1N4003 1A 200V	8c
1N4004 1A 400V	9c
1N4007 1A 1000V	18c
1N5626 5A 600V	50c

BRIDGES

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MDA3502 35A 200V	$4.20
MDA3504 35A 400V	$4.50
WO2 1.5A 200V	$0.75
WO4 1.5A 400V	$0.80

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C103YY .8A 60V	$0.80
C106A1 4A 100V	$0.95
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C122D 8A 400V	$2.50
C122E 8A 500V	$2.60

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SC151D 15A 500V	$2.50

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FND500 C.C.	$1.25
FND507 C.A.	$1.45
FND357 C.C.	$1.40
FND800 C.C.	$3.50
RED LEDS 10 for	$1.80
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KITS

ETI 480 100W module kit includes Heatsink Bracket	$19.75
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12 Volt Siren Kits	
1. "Whip"	$8.00
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TRANSISTORS

PN3563	25c
PN3564	25c
PN3565	25c
PN3566	25c
PN3568	25c
PN3569	25c
PN3638	25c
PN3640	25c
PN3641	25c
PN3642	25c
PN3643	25c
PN3645	25c
BF115	90c
BF180	75c
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BC338	30c
2N5589	$5.90
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2N5591	$10.50
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377	$2.75
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380 14 pin	$1.40
381	$2.00
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387	$1.90
555	35c
556	85c
566	$2.50
565	$1.95
567	$2.65
709	75c
723	55c
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78HGKC	$8.50
78H05	$7.90
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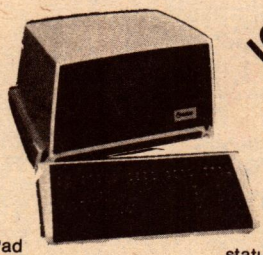

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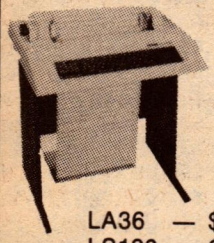

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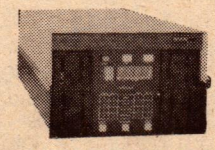

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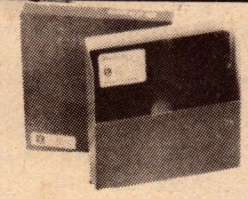

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New game programs for your 2650 computer:

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Here are three very interesting programs for microcomputer systems based on the Signetics 2650, developed by a father and son team from Hobart. With them, you will be able to program and play your own computer music, play John Conway's game "Life", and test your mental endurance with the letter rearrangement game "Rotate".

by PETER and HUGH CAMPBELL
19 Brushy Creek Road, Lenah Valley Tasmania 7008.

The "Music" program occupies locations X'4A0 to X'5D3, and uses Pipbug routines. It contains absolute addresses, and is not easily relocated. The music is generated at the flag output of the 2650, and some form of audio transducer is required. This can simply be an audio amplifier and speaker, connected via a suitable attenuator, to the buffered flag output of the CPU.

Monotonic musical notes are generated by pulsing the flag output at suitable rates, with the program "reading" the music from a section of memory. The timing of the music is determined by a time value called "UNIT", which is an even number of up to 15 bits, such that X'5160 is about 1/32 of a second.

Each note is specified by two bytes. The first byte represents the number of UNITs that the note will last: X'01 gives a duration of 1 UNIT, while X'00 gives 256 UNITs, or 8 seconds with a UNIT value of X'5160.

The second byte is split into three fields. The most significant bit, bit 7, indicates either a note (0) or a rest (1). The next three bits, bits 4, 5 and 6, specify the octave. 111 represents the top octave, while 000 represents the lowest. In practice, the three lowest octaves are not usable, giving a range of only five octaves.

The remaining four bits in the second byte represent the note within the octave. The first note in any octave is E, represented by X'0, while the last note is D sharp, represented by X'B.

For rests, bits 6 to 0 are not used, so all rests become X'80.

It is best to start and end all programs (tunes!) with X'80 80, a long rest, to separate the music from the noises Pipbug makes while communicating with the terminal. To signify the end of a tune, insert X'02FF after the long rest.

Fig. 1 is a hexadecimal listing of the program, as well as two tunes. "Yankee Doodle" occupies locations X'5D4 to X'6B7, and requires a unit value of X'2800, while "Bach" occupies locations X'6B8 to X'7A3, and requires a unit value of X'7000.

To run the program, type: G68C (address of first note) (value of unit) cr. The last two parameters are optional. If they are not given, the program will use the previous values. Thus to play "Yankee Doodle" type: G58C 5D4 2800cr; and for "Bach" type: G58C 6B8 7000cr.

The second program presented here is called "Rotate". The computer generates a 4 x 4 array of the first 16 letters of the alphabet, arranged in a random order. The object of the game is to rearrange the array into the following form:

```
A B C D
E F G H
I J K L
M N O P
```

The array can only be rearranged by rotating blocks of four letters clockwise. The block to be rotated is specified by the letter in its top left hand corner. It is invalid to try to rotate by calling letters on either the bottom row or the right hand column of the array.

If a mistake is made, it can be corrected once between valid rotations. Any two adjacent letters can be exchanged, with the proviso that only one exchange is permitted. When the required pattern has been achieved, or when the game is aborted, the program will print out the number of moves used.

The program occupies locations X'440 to X'5C7, and uses routines from Pipbug. To run the program, type G440cr, and the computer will respond with "PRESS ANY KEY". Once this has been done, a random pattern will be generated and printed, and the prompt message "ROTATE:" given.

A sample game is shown in Fig. 2. If you wish to rotate a particular block, type the letter in the top left hand corner of that block. If you wish to cancel a move, type carriage return, and the program will respond with "CANCEL", and then reprint the last but one block.

If you wish to exchange two adjacent letters, type X. The program will respond with "EXCHANGE:", and expect you to type in the two desired letters. It will supply the comma separating the letters. If you cannot solve a particular pattern, type Z, and this will abort the game.

An average pattern, with only one exchange permitted, should take between 25 and 30 moves. Early attempts may take more. A hexadecimal listing of the complete program is given in Fig. 3.

The third and final program is the game of "Life", which is now well-known in computer circles. Life was originated by American computer programmer John Conway, and details of it were first published in the October 1970 issue of "Scientific American", in Martin Gardner's column

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LIFE: HEX LISTING

```
0C00 7B 4C 75 FF C4 F9 C8 27 12 1A 7D 3B 25 12 1A 78
0C10 3E 1E 3B 1C 12 9A 04 05 59 1B 07 3B 13 12 1A 04
0C20 05 F9 C9 0B 1B 32 04 0D 3E 0F 04 0A 3E 0B 17 59
0C30 3B 00 0F 7B 14 14 FF 7D 17 77 10 05 08 3F 71 3E
0C40 6F 74 40 3B 6B 50 1A 04 74 40 1E 03 76 40 14 F9
0C50 72 76 4C 3E 5B 75 10 17 1B 1C 77 18 05 00 06 08
0C60 12 1A 7D 14 3B 4C 3F 48 12 14 D0 51 FA 78 3B 40
0C70 45 7F 01 75 18 17 05 01 3F 0E B6 04 3A 3F 0C 39
0C80 3F 0C 5A F4 50 1C 0C E8 E4 47 1C 0D 8A F4 4E 98
0C90 6F 3F 0C 39 05 46 20 CD 4E EE 59 7B 05 FF 3F 0C
0CA0 26 06 08 07 00 D3 3F 0C 5A E4 20 18 22 E4 4F 18
0CB0 22 E4 0A 18 10 E4 0D 98 6D 3F 0C 39 85 01 45 FC
0CC0 A5 01 1E 5D D3 FF 7D 03 CD 2E F4 65 03 1B 0F 04
0CD0 2F 1F C2 67 01 3F 0C 39 FA 4B 03 CD 2E F4 F5 03
0CE0 FC 0C A1 F5 3F BC 0C 9E 05 FF 3F 0C 26 06 00 CA
0CF0 15 07 08 0D 2E F4 DA 00 9A 02 CA 0A D0 FE 77 F5
0D00 03 98 6E A5 04 06 00 98 06 85 04 1B 1D FB 09 07
0D10 08 0D 2E F4 77 10 C2 52 77 10 D2 1A 04 04 20 1B
0120 02 04 4F 3F 0C 39 FA 65 65 03 E5 3F 9C 0C EA 04
0130 0D 3E F1 0D 0E EF E5 09 99 04 A5 0A 1B 78 01 24
0140 30 3F 0C 39 0D 0E EE 06 00 E5 09 99 0E 86 01 E6
0150 09 99 02 06 00 A5 0A E5 09 19 72 02 24 30 3F 0C
0160 39 01 24 30 3F 0C 39 1F 0C 7B 3E 0B 07 09 C2 82
0170 FB 7D C2 3B 02 82 17 3F 0C 5A E4 30 1A 79 E4 39
0180 19 75 C3 3F 0C 39 03 44 0F 17 3F 0C 39 3E 5B CC
0190 0E EL 05 0C E4 0C 1C 0E B0 05 15 E4 0F 1A F8 05
01A0 1B F4 37 1A F2 05 21 E4 4C 1A EC 05 27 1B E8 05
01B0 04 06 04 01 4E F4 CE 4F 34 0E 6F 30 CD 6E F0 5A
01C0 02 06 04 59 6E 05 FF 07 03 85 03 3B 33 08 2F 50
01D0 50 C8 2A 3B 14 A5 03 3B 27 08 22 C8 22 3B 0A 0D
01E0 2E F4 77 10 C1 07 08 1B 3B 0A 13 08 10 CA 0E D0
01F0 E0 C8 0E 44 03 CF 6E 20 FB 02 07 03 17 00 00 00
0F00 20 C8 7A C8 79 06 C3 0D 2F F0 44 55 88 70 C8 6E
0E10 0D 6F F0 50 44 55 88 65 C8 63 85 03 FA 69 A5 0C
0F20 17 00 00 00 FF 0E 75 10 F5 03 18 04 3E 52 1E 04
0E30 08 4D C8 49 75 10 3F 0D E9 77 10 08 64 88 63 88
0E40 62 E4 04 18 10 E4 03 18 05 01 1A 05 1E 07 01 1A
0E50 04 66 01 25 80 L1 5E 4C 75 10 01 44 03 C2 0E 6E
0E60 F0 CL 6E F0 77 10 C1 75 10 CE 6E F0 F5 03 9C 0D
0E70 DF E5 3F 9C 0D C9 05 04 0D 4E FC CD 6F 30 59 78
0E80 77 10 02 1C 0E A8 06 00 75 10 05 01 8D 0E EE E5
0E90 64 98 0A 05 01 8E 0E FF CL 0E EF 05 00 CD 0E EE
0EA0 0C 0E ED A4 01 CC 0E ED E4 00 1C 0C E8 1F 0D AF
0EB0 3F 0E B6 1F 0D AF 0L 2E BF E4 00 14 3F 0C 39 1E
0EC0 75 0D 0A 22 4C 49 46 45 22 0D 0A 00 20 3D 20 32
0ED0 35 36 47 2E 00 20 3C 30 35 53 00 20 3C 31 35 53
0EE0 00 20 3C 32 30 53 00 20 3C 32 35 53 00
```

ROTATE: HEX LISTING

```
0440 06 FF 3F 05 64 05 08 07 F5 1B 00 12 9A 06 D9 79
0450 DB 79 1B 71 06 05 66 80 F6 03 18 0A 26 FF F6 03
0460 18 02 66 80 26 FF 52 CA 6C 46 0F 3F 04 C4 18 64
0470 19 62 DF 60 07 0F 1F 04 B5 3F 05 44 06 0F 3F 05
0480 64 3F 02 86 E4 58 1C 05 03 E4 0D 18 0D 3F 04 E7
0490 58 6F 3B 30 98 1A 06 19 1B 64 03 C2 3B 26 18 76
04A0 3E 22 3B 20 07 0F 06 21 3F 05 64 A5 01 95 1E 49
04B0 02 C3 85 67 95 06 40 0E 25 76 E2 18 7A 60 1C 05
04C0 56 1F 04 79 F6 03 14 F6 0C 14 0E 65 BB C8 13 0E
04D0 65 BC CE 65 BE 0E 65 B8 CE 65 BC 0E 65 B7 CE 65
04E0 B8 04 4F CE 65 B7 17 E4 5A 1C 05 58 E4 41 1A 12
04F0 E4 50 19 0E 06 10 EE 45 B7 18 04 5A 79 9E 22 3F
0500 02 B4 17 06 28 3F 05 64 3F 02 86 3B 5A 58 79 02
0510 C3 04 2C 3F 02 B4 3F 02 86 3B 4C 58 79 02 A3 9A
0520 02 03 A2 E4 01 18 08 E4 04 18 04 06 19 1B 56 0E
0530 65 B7 C8 07 0F 65 B7 CE 65 B7 04 41 CF 65 B7 07
0540 CF 1F 04 B2 06 01 CE 25 B3 14 3F 02 B4 F6 03 98
0550 75 3F 00 8A 1B 70 3B 6C 06 34 3B 08 3F 02 69 3E
0560 03 1F 04 40 0E 25 6D 14 3F 02 B4 1B 77 0A 50 52
0570 45 53 53 20 41 4E 59 20 4B 45 59 00 00 0A 52 4F
0580 54 41 54 45 3A 20 00 0A 57 48 41 54 3F 20 00 43
0590 41 4E 43 45 4C 00 0A 45 58 43 48 41 4E 47 45 3A
05A0 20 00 0A 59 4F 55 20 54 4F 4F 4B 20 00 20 4D 4F
05B0 56 45 53 0A 00 0D 0A 4F 4C 44 49 45 4A 4C 50 48
05C0 46 41 4B 42 43 4E 47 00
```

MUSIC: HEX LISTING

```
04A0 04 00 0C A5 56 1E 05 58 C2 44 70 24 70 C1 51 51
04B0 51 81 51 77 10 83 C3 86 00 75 11 46 0F D2 0E 65
04C0 BC C3 0E 25 BC 06 FF E5 00 18 05 D0 D3 D2 F9 7B
04D0 75 01 84 80 87 00 86 00 CB 22 CA 1F 77 10 87 44
04E0 86 01 9A 06 87 0F 86 00 1A 7A 0D 85 56 77 01 AB
04F0 09 AA 06 76 40 04 08 1B 31 28 00 F9 5A AB 7B AA
0500 78 93 07 8C 8B 76 8A 73 9A 06 87 0E 86 00 1A 7A
0510 53 13 53 B5 01 98 03 1B 01 C0 47 03 9F 05 1F C0
0520 C0 C0 93 12 24 40 92 13 77 11 AB 50 AA 4D 9A 05
0530 93 07 80 1B 4F F9 46 44 01 4C 04 FC 64 18 93 8F
0540 04 FC 8E 04 FB 75 11 0E 0E 0A 0B 87 02 86 00 CB
0550 06 CA 03 1F 04 A0 06 B6 77 10 E4 FF 1C 00 22 09
0560 F5 87 8A 86 00 9A 06 87 0E 86 00 1A 7A 74 40 75
0570 01 86 02 77 01 AF 04 FA AE 04 F9 87 1E 86 00 87
0580 0E 86 00 1A 7A F9 6E A6 02 1F 05 45 75 FF 3F 02
0590 DB 0C 04 2A 98 06 0A 23 09 20 1B 04 CA 1D C9 1A
05A0 CE 05 57 CD 05 56 3F 02 DB 77 08 0C 04 2A 1C 04
05B0 A0 CE 04 FA CD 04 F9 1F 04 A0 05 D4 02 FC 11 2F
05C0 1E 97 2B 3E 37 2F 42 74 4D 17 57 22 60 9C 69 8E
05D0 72 00 79 F8
```

YANKEE DOODLE: HEX LISTING

```
05D4 80 80 08 43 08 80 08 43 08 80 08 45
05E0 08 80 08 47 08 80 08 43 08 80 08 47 08 80 08 45
05F0 08 80 08 3A 08 80 08 43 08 80 08 43 08 80 08 45
0600 08 80 08 47 08 80 14 43 08 80 08 42 08 80 08 3A
0610 08 80 08 43 08 80 08 43 08 80 08 45 08 80 08 47
0620 08 80 08 48 08 80 08 47 08 80 08 45 08 80 08 43
0630 08 80 08 42 08 80 08 3A 08 80 08 40 08 80 08 42
0640 08 80 10 43 0C 80 10 43 10 80 08 40 10 80 08 42
0650 02 80 08 40 08 80 08 3A 08 80 08 40 08 80 08 42
0660 08 80 10 43 10 80 08 3A 10 80 08 40 02 80 08 3A
0670 08 80 08 38 08 80 10 37 10 80 10 3A 10 80 08 40
0680 10 80 08 42 02 80 08 40 08 80 08 3A 08 80 08 40
0690 08 80 08 42 08 80 08 43 08 80 08 40 08 80 08 3A
06A0 08 80 08 43 08 80 08 42 08 80 08 45 08 80 10 43
06B0 0C 80 10 43 80 80 02 FF
```

BACH: HEX LISTING

```
06B8 80 80 06 43 06 45 04 47
06C0 04 4A 04 48 04 48 04 50 04 4A 04 4A 04 53 04 52
06D0 04 53 04 4A 04 47 04 43 04 45 04 47 04 40 04 4A
06E0 04 48 04 47 04 45 04 43 04 3A 04 43 04 42 18 43
06F0 0C 80 18 47 0C 48 18 4A 0C 4A 18 48 0C 47 18 45
0700 06 80 06 80 18 47 0C 48 18 4A 0C 47 06 45 03 47
0710 03 48 0C 47 0C 45 18 43 0C 80 02 80 06 43 06 45
0720 04 47 04 4A 04 48 04 48 04 50 04 4A 04 4A 04 53
0730 04 52 04 53 04 4A 04 47 04 43 04 45 04 47 04 40
0740 04 4A 04 48 04 47 04 45 04 43 04 3A 04 43 04 42
0750 04 43 04 47 04 4A 04 53 04 4A 04 47 04 43 04 47
0760 04 49 18 4A 06 80 02 80 03 80 06 43 06 45 04 47
0770 04 4A 04 48 04 48 04 50 04 4A 04 4A 04 53 04 52
0780 04 53 04 4A 04 47 04 43 04 45 04 47 04 40 04 4A
0790 04 48 04 47 04 45 04 43 04 3A 04 43 04 42 18 43
07A0 80 80 02 FF
```

Fig. 4 (top left): This is a hexadecimal listing of the Life program.

Fig. 1 (top right): The listing shown here is for the music program, and two tunes.

Fig. 3 (left). This is the listing for the game of Rotate. It uses routines from Pipbug.

"Mathematical Games". Further information was published in the November 1970, January 1971 and April 1971 issues of the same magazine.

Since it was first produced, Life programs have been developed by many different people (it is said to have been responsible for more "foreign order" computer time than anything else). People all over the world have played Life, and come up with many interesting patterns.

Life is a matrix game concerned with the life, death and birth of cells. Imagine each cell to be in a two-dimensional linear matrix, such that each cell location has eight possible neighbours, as shown:

1	2	3
4	X	5
6	7	8

The rules of cell life, death and birth are as follows:

1. A live cell will survive if it has two or three live neighbours.
2. A live cell will die if it has less than two or more than three live neighbours.
3. A birth in an empty cell will occur if it has exactly three live neighbours.
4. Births and deaths take place simultaneously.

To work with practical terminals the program operates with a limited size matrix, but makes it effectively "infinite" by having "wrap around" from side to side and from top to bottom.

In our version of Life, live cells are represented by O's, and dead or empty cells by blanks. The program starts with an initial pattern (fed in by the player), and calculates the new patterns "generation by generation".

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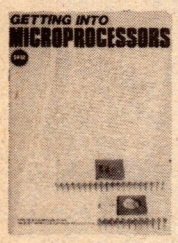

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```
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PRESS ANY KEY

OJMD
EPLI
BFHK
CNAG

ROTATE: F

OJMD
EPLI
BNFK
CAHG

ROTATE: N

OJMD
EPLI
BANK
CHFG

ROTATE: N

OJMD
EPLI
BAFN
CHGK

ROTATE: F

OJMD
EPLI
BAGF
CHKN

ROTATE:
        EXCHANGE: L,M

OJLD
EPMI
BAGF
CHKN

ROTATE: P

OJLD
EAPI
BGMF
CHKN

ROTATE: M

OJLD
EAPI
BGKM
CHNF

ROTATE: CANCEL

OJLD
EAPI
BGMF
CHKN

ROTATE: G

OJLD
EAPI
BHGF
CKMN

ROTATE:
        YOU TOOK 07 MOVES
```

Fig. 2 (above). Here is a sample printout from the Rotate game. The "Z" command was used to terminate the game.

Fig. 5 (at right on facing page): This sample listing is an example of the "Life" program in operation. This cell pattern stabilises at generation four.

Life and Rotate programs for the 2650

The program listing provided (Fig. 4) is intended for use with the Low Cost VDU of February and April 1978, and uses a matrix of 16 rows of 32 cells. To use the program, type GC00 cr, and then switch to the appropriate baud rate (110 or 300 baud). The type a U for 110 baud operation, or a Y for 300 baud operation.

The program will respond with the word "LIFE", followed by the prompt character ":".

If you respond with "N", the program will expect a new matrix to be supplied. The program will echo the N, followed by a carriage return and line feed. A pattern may then be written in (or "seeded") by using the space bar for blanks (these are printed as dots), O's (for Oboe) for live cells, and line feeds (LF) for new lines.

Blanks are not required on the right hand side of the pattern. Carriage return (CR) will permit overwriting of a line, allowing error correction. Once your pattern is complete, use LFs if necessary to advance to the bottom of the matrix.

Once the pattern is completed, the program will reprint it, and give the prompt sign again. If you now respond with a Gxx, X'xx generations will be evolved, with a printout after the last generation. G00 will produce printout after 256 generations, while G01 will produce a printout after only one generation. And so on . . .

Immediately after you have typed in this command, the program will respond with a message such as <15S, to indicate that in less than 15 seconds it will print out the result of the Gxx instruction. After printing the result the new generation count and prompt will appear at the bottom left hand corner of the screen. This may overwrite live cells, so try and keep your patterns in the centre of the screen (patterns to the right will wrap around to the left).

The remaining instruction is P, which causes the program to printout the existing matrix. The instruction is not used a great deal.

Fig. 5 shows the result of a simple pattern. This stabilises after four generations, and then continues forever unchanged.

One of the most interesting and simple patterns has been named the "Glider". The seed for this is shown below:

```
  0
   0
000
```

Can you work out what will happen with this pattern? (the name is a good clue!).

If your VDU can cope with 24 lines, the program can be adapted to produce a 24 x 32 matrix. The EME-1 VDU, described in the January and February 1977 issues, is such a terminal.

To do this change the following locations:

location	C95	from	46	to	66
	CE4		3F		5F
	D28		3F		5F
	D88		34		54
	D88		3Ø		5Ø
	E72		3F		5F
	E7D		3Ø		5Ø

The complete Life program occupies locations X'C00 to X'EEC inclusive, and requires additional RAM extending to X'F54. However, the first part of the program is a self-contained I/O module containing a baud rate initialisation routine and some subroutines which duplicate the functions of Pipbug's CHIN, COUT and CRLF subroutines. The I/O module may be used by other programs, either where it is or moved elsewhere.

The memory locations occupied by the module are from X'C00 to X'C75 inclusive. The baud rate initialisation routine begins at X'C00 and ends at X'C58-59 with a BCTR, UN instruction which currently produces a branch to the start of the main section of the Life program at X'C76. To make the routine branch to the start of another program instead, the displacement of this instruction would need to be changed, or possibly the instruction changed into a BCTA,UN type.

Incidentally although the I/O module at present offers a choice of either 110 or 300 baud operation, the higher rate may be changed quite easily to 1200 baud if you desire (and if your terminal will work at this speed). Simply replace the contents of location X'C18 (currently X'59) with X'14.

To use the baud rate initialisation routine, type G C00cr. Then type U for 110 baud operation, Y for 300 baud operation (assuming the routine is set to give this alternative speed), or E for 1200 baud operation. Of course it is necessary to switch the terminal for the appropriate baud rate as well.

Note also that you may need to reduce the value of hash filter capacitor on the asynchronous input of your computer, in order to operate reliably at 1200 baud (or even 300 baud in some cases). In the case of the EA 2650 Mini Computer, the value of the capacitor should be reduced from 1.5uF to about 0.1uF.

Once it has selected the desired baud rate, the initialisation routine will branch to the desired main program, with the I/O subroutines set up for the correct baud rate.

The actual subroutines are used in exactly the same manner as those in Pipbug. The calling addresses are:

CRLF	X'C26
CHIN	X'C5A
COUT	X'C39

Needless to say, you can also run the Life program at 1200 baud, simply by making the above change to the I/O module with the output branch still pointing to X'C76.

However, if you are running Life at 1200 baud, it is better to change the program so that it prints out after every generation, and stops automatically when the pattern stabilises. To do this, change the following locations:

location	D68	from	ØC	to	ØD
	D69		7B		A9
	DA9		1A		77
	DAA		EC		1Ø
	DAB		Ø5		Ø6
	DAC		27		ØØ
	DAD		1B		75
	DAE		E8		1Ø
	E84		ØE		ØC
	E85		A8		7B
	EAØ		ØC		Ø4
	EA1		ØE		ØØ
	EA2		E0		Ø5
	EA3		A4		Ø2
	EA4		Ø1		Ø6
	EA5		CC		Ø2
	EA6		ØE		F8
	EA7		ED		7E
	EA8		E4		F9
	EA9		ØØ		7C
	EAA		1C		FA
	EAB		ØC		7A
	EAC		E8		CØ
	EAD		1F		1F
	EAE		ØD		ØC
	EAF		AF		E8

Once you have made these modifications, simply feed in a starting pattern (using the N command), and sit back and watch. The program will continue until a stable pattern is achieved, at which time it will stop. Note, however, that it cannot detect recurring cyclical patterns, so watch out for these. To stop them, you will have to use the reset facility of the 2650.

```
                 0
GENERATION 1   0 0 0

                 0
GENERATION 2     0 0
                 0

                 0 0
GENERATION 3     0 0
                 0 0

                 0 0
GENERATION 4   0     0
                 0 0

                 0 0
GENERATION 5   0     0
                 0 0
```

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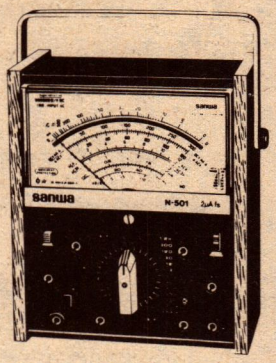
AX-303TR

44μA meter movement — Si diode protection against pulse input.
Measures hFE (0-1000) by using the extra connector.



N-501

2μA suspension movement — 0.05mA/1mV resolution.
Double protection — fuse & Si diode.
Constant 1MΩ input impedance (ACV) — RF-diode rectified current direct to movement.

BX-505

Fast-response, 24μA movement — fuse & diode protected with high resolution factor. (0.4μA/scale division)
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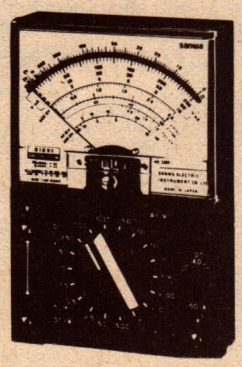

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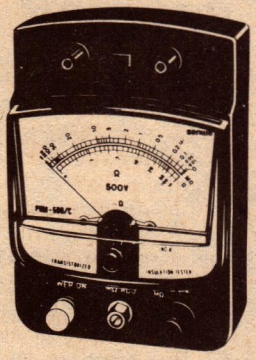
44μA movement — quality performance, diode protected.
Temperature measurement of −30°C to +150°C with extra scale.

CAM-250D

Clamp meter
Economical and multi-function. Single motion core arm.
Compact yet provides 4 ranges on ACA and 2 ranges on ACV.



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Has constant voltage impressed irrespective of the value of resistance checked.

N-501

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AX-303TR

● ±DCV 0-0.3-3-12-30-120-300-1200 ● ACV 0-6-30-120-300-1200 ● ±DCV 0.60μ -3m-30m-0.3-12 ● Ω x 1- x 10- x 1k- x 10k (max. 20M)

U-60D

● DCV 0-0.1-0.5-2.5-10-50-250 -1k-25k (w/HV probe) ● DCA 0-50μ -2.5-50-500m ● ACV 0-2.5-10-50-250-1k ● Ω x 1-x 10-x 100- x 1k (max. 5M)

BX-505

● ±DCV 0-0.12-3-12-30-120-300-1200-30k (w/HV probe) ● ±DCA 0-30μ -3m-30m-0.3-12 ● ACV 0-6-30-120-300-1200 ● ACA 0-12 ● Ω x 1-x 10-x 1k-x 10k (max. 20M)

CAM-250D

● ACA 6-30-60-300 ● ACV 300-600 ● kΩ 0-50k ● Batt. 1.5V x 1

PDM-500/C

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Heath's H-11 16-bit minicomputer kit

The recently-released Heathkit H-11 is the first fully professional 16-bit minicomputer system to be made available as a kit. Based on the Digital Equipment LSI-11, it is able to make use of the vast amount of software available for the well-known PDP-11 series of computers. This review of the Heathkit H-11 has been written by an experienced user.

by D. W. RICKARD

Computer Centre, Australian Institute of Marine Science
P.M.B. No. 3, MSO Townsville, 4810

The Heathkit H-11 digital computer system is now available in Australia. Based as it is on the Digital Equipment Corporation (DEC) LSI-11 16-bit computer, this is the first fully professional mini-computer to be made available as a kit.

Actually, to call the H-11 a kit is a bit of a misnomer. The LSI-11 central processor board comes completely assembled and tested by DEC, and includes an onboard 4K by 16-bit memory. The constructor only has to assemble the heavy duty switching mode power supply, the back plane and sockets, and the case. Total time to get a system operational is usually under 30 hours.

It is well to note that the H-11 does not include any form of terminal, either VDU or hard copy, nor does it include interfaces for these devices. Like all PDP-11 systems, the H-11 has available for connection to it a range of interfaces and I/O devices which must be ordered separately. For example, the H-9 Heathkit VDU and the Heath H-36 hard copy terminal (actually a DEC LA-36 DECwriter II) are available and the H-11-5 serial interface to connect them to the LSI-11 bus. Similarly, the Heathkit H-10 paper tape reader/punch combination is available with the H-11-2 parallel interface module to connect to the LSI-11 bus. A 4K by 16-bit memory module, the H-11-1 is also available.

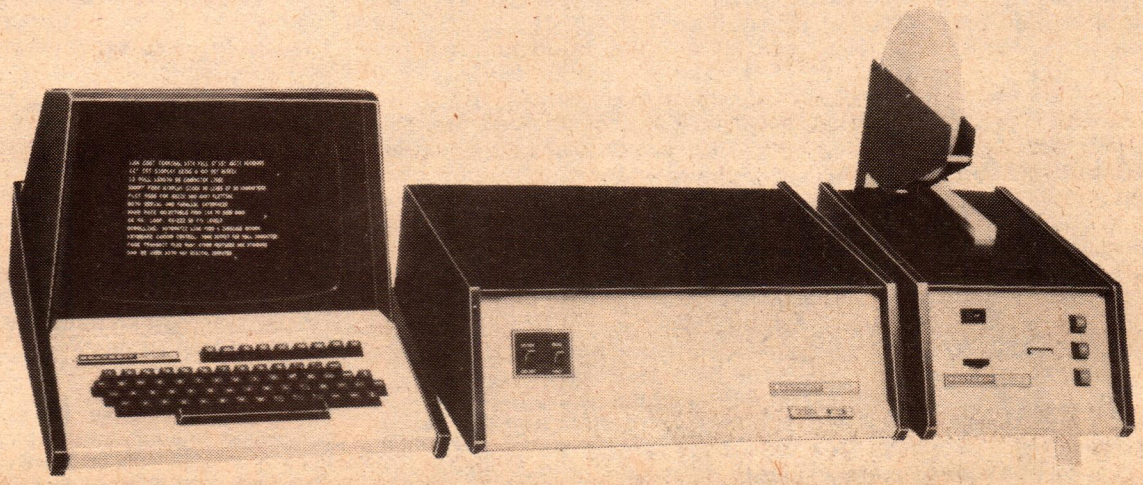
A word of warning should be given about these boards. Due to the close spacing of boards on the back plane, the height of components must be kept to a minimum. However the 820pF capacitors supplied for +5V bypass exceed this height and foul the adjacent board. It is quite possible for the tops to be scraped off the capacitors and for the exposed metalisation to short out against the next board. If this happens to be the LSI-11 CPU board the results could be disastrous. It has been found that miniature .001 uF capacitors are an effective substitute.

The construction documentation is up to the usual high standard of Heath. However, during construction of the power supply a couple of anomalies in component numbering will become apparent. These can be resolved with reference to the parts list.

The software supplied with the H-11 is in fact the standard DEC PTS (Paper Tape Software) system. It comprises ED-11 (a source editing program), PAL-11S (an assembler producing relocatable object modules), LINK-11S (which links together different object modules to produce an absolute binary load module), IOX (an input/output executive to be incorporated into user written programs), ODT (an octal debugging system), BASIC and FOCAL.

Because of the use of the LSI-11, the H-11 is software compatible with the great range of PDP-11 computers, and much of this software can be run on the H-11. Note, however, that the PTS software requires as a minimum an ASR-33 teletype with paper tape reader and punch. This is only suitable for small program development, and any reasonable size programs really necessitate an LA-36 hard copy terminal and a separate high speed paper tape reader/punch.

Most of the software will run in 4K x 16-bit words but this sometimes leaves very little user space. BASIC is the worst offender, and should only be attempted in systems with 8K x 16-bit words or greater. FOCAL is an interpretative language somewhat like BASIC but can be extremely recursive, and because all commands can be cut to the first letter only, user storage requirements can be minimised. Because of its inbuilt scheduling facilities and powerful I/O facilities, FOCAL can be used for implementing quite high level



The Heath H-11 is shown here in the centre, with the matching H-9 VDU to the left and the H-10 paper tape reader/punch to the right. A hard copy terminal (H-36) is also available.

Here the Heath H-11 is shown with an SMS dual floppy disc unit and a Micro-Tec model 70 video terminal. The H-11 runs a great deal of the software written for Digital Equipment PDP-11 computers.

data acquisition or industrial control systems.

One program which is not included in the Heath supplied set but can be obtained from DECUS, the DEC Users Society, is called PALEDIT. This is a combined editor-assembler which requires 8K x 16-words in which to run. It allows both the editor, the assembler, and the user's source code to all be in memory at the same time. The editor is used to create assembler source code stored in memory. Then the user jumps to the assembler and assembles the source code also in memory. If any errors are found, you jump back to the editor, make the necessary corrections, back to the assembler, etc, until such time as an error free assembly is achieved. Due to the fact that the program only has to be loaded once, and that the assembler is getting its input from high-speed memory and not a paper tape reader, this is a tremendously fast system and worth some effort in obtaining the program.

On the whole, the software documentation for the H-11 is very good. Most of it is in fact just a copy of the equivalent DEC manuals. It pays to read all the software manuals through at least twice before attempting any programming, as often some small critical point is not fully explained except in the appendices.

A number of debugging facilities are implemented in micro-code within the LSI-11 processor itself. This allows display and alteration of register, memory and peripheral contents.

The LSI-11 has a 16 bit address bus. However, in order to be able to directly address bytes, address bit 0 is used for byte selection, thus giving a 32K x 16-bit word address space. All peripheral device registers are addressed the same as memory, but by convention DEC allocate the upper 4K words to peripheral addresses, thus allowing 28K words of memory to be used.

It might also be pointed out that the LSI-11 can be fitted with an additional 40 pin ROM which provides the full Floating Point Instruction Set (FIS) similar to the large PDP-11/34 and 11/40. However, the PTS software supplied does not make use of the FIS and unless you can obtain other versions of BASIC or FOCAL which do use it, the chip is not of much value.

There is one other facility which Heath have left out. The LSI-11 incorporates a mains frequency real time clock. This is used by FOCAL for its clock and scheduling functions, however, it must be disabled during the original program loading sequence. A link is fitted on the power supply board to allow enabling/disabling of the clock signal. As this is extremely inconvenient, it was found far preferable to install a small toggle switch on the back panel and connect it to the points on the power supply board where the link is normally fitted.

The basic H-11 back plane has eight double height slots available. The LSI-11 takes two of these, the terminal interface and the paper tape reader punch each take another double slot, and the 4K x 16 bit memory boards each take one double height slot. Into the remaining slots can be plugged an amazing range of devices from colour graphics interfaces to 64 channel analog-to-digital converter subsystems; from floppy disc to cartridge disc systems. Due to its high popularity, an enormous range of LSI-11 bus compatible devices are available, both from Digital Equipment Corporation and other specialist manufacturers, eg, ADAC, MDB, Analog Devices, Burr-Brown, etc, and these can all be plugged into the H-11.

Heath have indicated that they hope very soon to release an inexpensive floppy disc system for the H-11. As this will most likely support the DEC RT-11 real time operating system which supports FORTRAN and APL in addition to BASIC and FOCAL, the future for these systems looks quite good.

The major application for the H-11 then would appear to be not with hobbyists, but with small laboratories and other professional organisations in data acquisition and control functions, perhaps even front-ending to larger computer systems. In these cases, the slightly higher cost of hardware of the H-11 compared with some of the 8 bit micro systems will be more than offset by its extreme usability and short software development times, due to excellent high level languages and interface capability.

Further information on the H-11 is available from the Australian agents for Heath, Warburton Franki Pty Ltd, with offices in most states.

Footnote:

The views expressed are those of the author and do not necessarily reflect those of the Australian Institute of Marine Science or of the Australian Government, nor do they imply endorsement of any product by these bodies.

At last:
A budget-priced mosaic printer.

The new EUYIOE series is ideal for microprocessor-based systems or data logging.

How often have you needed a small printer which can produce many characters, alpha-numerals, symbols and graphs at 2 lines per second on 60 mm paper?

Matsushita's new quiet non-impact Electrosensitive Printers use a 7 x 5 dot matrix and a choice of characters per line (15, 21, 32 or 40).

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But with all these features only a low 24 volts is needed to operate the units.

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One motor drives both the printing head and recording paper through a dependable mangle gear. Special overall design reduces the number of parts needed and the natural result is less weight, smaller size and most important, greater reliability.

Choice of drive units.

To drive the EUY10E printer you have the choice of two interface units. EUYPUD022A is a basic drive unit which provides signals to power the motor and printing head. It offers the user maximum versatility and flexibility. EUYPUD022A is designed to interface between the printer and microprocessor kits such as 2650KT9500, SC/MP or DE.

The EUYPUD022A contains a full 64 ASC11 character generator.

Specifications

Printing method	Electrosensitive
No. of characters per line	15, 21, 32, 40
Types of characters	Alpha-numeral, symbol, graph
Character composition	7 x 5 dot matrix
Printing speed	Approx. 2 lines/sec.
Character height	2.4 ± 0.2 mm (0.094″ ± 0.008″)
Input voltage	−24V ± 5%
Current	300mA
Life	MCBF 1 x 10^6 lines
Dimensions	90.5(W) x 110(D) x 42.5(H) mm 3.56(W) x 4.33(D) x 1.67(H) inch
Weight (approx:)	370 g (0.814 lb)

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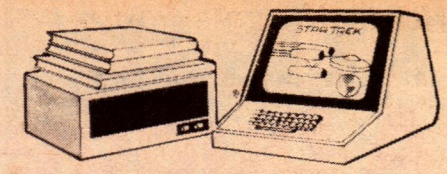


Pascal chip set

Western Digital Corporation has developed a 16-bit computer chip set which directly executes Pascal object programs, at a speed at least five times faster than is possible with conventional system software. Because the chip set implements an ideal P-machine directly, it eliminates the need for a host operating system and interpreter.

Designated the Pascal "MicroEngine" product line, the chip set offers the version of Pascal language developed by the University of California at San Diego (UCSD). This version of Pascal, derived from the original language developed at the Swiss Institute of Technology in 1971, is generally regarded by the computer industry as an excellent implementation language for business, industrial and computer-aided instruction applications.

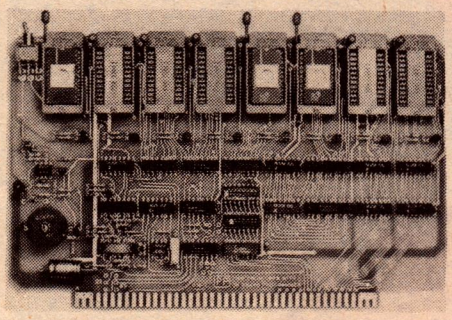
The Western Digital chip set consists of four MOS LSI parts: an arithmetic chip that contains microinstruction decode, ALU and the register file; a microsequencer chip that contains macroinstruction decode, portions of the control circuitry, microinstruction counters and I/O control logic; and two 512 x 22 ROMs that contain the microinstructions and microdiagnostics.

Additional features of the chip set include user-defined bus configuration, four levels of interrupts, single and multi-byte instructions, hardware floating point, stack architecture, 3MHz four-phase clock and TTL compatible three state interface.

Western Digital has also announced a packaged software development computer using the MicroEngine chips. This offers 32K (64K bytes) of RAM, full DMA, floppy disc controller two RS-232 ports and two 8-bit parallel ports — all on a 200 x 400mm PC board packaged with its three power supplies in a low-profile enclosure.

Further details will be available shortly from Daneva Control Pty Ltd, 70 Bay Road, Sandringham, Victoria 3191.

16K PROM Programmer



A new PROM memory card which provides for up to 16K bytes of PROM storage together with an integral programmer has been developed by Pennywise Peripherals. The card is designed for single +5V supply 16K bit EPROMs, such as the Intel 2716 or TI TMS 2516.

All PROMs on the card may be read in the normal manner. Any PROM may also be programmed, merely by performing a normal Write to the memory addresses concerned. The card generates all programming voltages and signals internally, and automatically pulses the PROM for the correct time. The processor can detect when the programming is complete by reading the address and verifying — invalid data is returned until programming is complete.

The 16K bytes on the card are divided into two 8K blocks, each of which is switch selectable to any 8K area of 64K memory space. The card has a write protect switch to prevent accidental programming.

The PCB measures 247.5 x 152.5mm and has plated-through holes. The edge connector is for the Motorola EXORcisor bus, as used in the MEK6800D2 kit. However the read/write control logic is jumper selectable for a variety of other processors, including the 8080/5, 6502, 2650 and SC/MP. The card requires only a single +5V supply.

Price of the card, fully assembled and tested with low insertion-force sockets but without PROMs, is expected to be $197.30 plus tax. Zero insertion force sockets are an optional extra for $38.50 plus tax additional.

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Heath H8 gets floppy

Heathkit has released a floppy-disc add-on for its H8 microcomputer system. Designated the WH17, the new unit consists of an interface/disc controller PCB, power supply and drive unit with either one or two 125mm minifloppy disc drives. Hard sectoring is used, giving 102K bytes of storage per disc.

The WH17 comes fully assembled and factory tested, and complete with a disc which contains all required H8 operating systems: the Heath Disc Operating System (HDOS), a console debugging program BUG-8, a text editor HASL-8, and extended Benton Harbour BASIC.

A lower-cost kit version of the unit is predicted soon, also a similar floppy disc unit for the 16-bit H11 computer system.

Further information is available from Warburton Franki Pty Ltd, 199 Parramatta Road, Auburn, NSW 2144.

Tandy expanding

Tandy/Radio Shack is to open 50 computer sales and service stores throughout the USA during 1978-79, it has been announced by Lewis Kornfield — president of Tandy Corporation's Radio Shack division. Most are to be separate from existing Radio Shack stores, and their purpose will be to assist existing stores as well as develop quantity sales of TRS-80 microcomputer systems to businesses and institutions.

The new centres will also sell a variety of parts, packaged software, and possibly hardware from other manufacturers.

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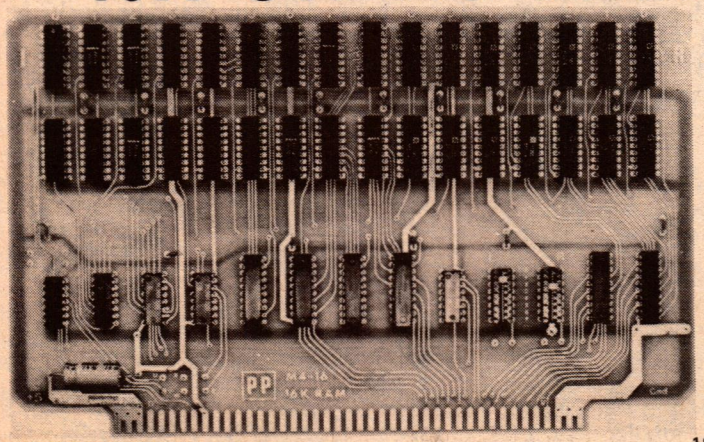

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Classical Recordings

Reviewed by Julian Russell

Debussy — Pelleas & Melisande: 'close to perfection'

DEBUSSY — Pelleas and Melisande. Complete Opera. Camille Maurane (Pelleas); Erna Spoorenberg (Melisande); George London (Golaud); Guus Hoekman (Arkel); Josephine Veasey (Genevieve); Rosine Bredy (Ynoild) and others with the Chorus of the Grand Theatre of Geneva and the Orchestra of the Swiss Romande conducted by Ernest Ansermet. World Record Club Stereo R/04266-7-8. (Three boxed discs.)

Since outside France and Belgium so little is known about one of the greatest operas written this century — Pelleas and Melisande — I feel justified in taking more space than usually allotted such reviews.

First, Pelleas is quite different from any other opera the general opera goer has ever seen or is likely even to imagine. It is even unique among Debussy's own works. Its characters, dreamlike though paradoxically firmly drawn, move against a mysterious timeless background stated by its author Maeterlinck to be medieval Germany. To increase its mystery he called it Allemonde, not Allemagne. It is in five acts consisting of 14 mostly brief scenes separated by orchestral interludes. The characters use a kind of continuous recitative, except for one short ditty sung by Melisande.

The orchestra provides a flexible, flowing accompaniment, mostly subdued, if one excepts the powerfully dramatic scene between Golaud and Ynoild. It simultaneously fills in the characters and picturesquely describes the shadowy background. Debussy abhorred exaggeration and you will find none in this opera. At first hearing, it is deceptively placid.

The middle-aged Golaud finds a young girl in a dark forest weeping beside a well but she refuses to reveal her identity. Indeed, you never learn her origin. He takes her with him to his father's gloomy castle and marries her. She falls innocently in love with Golaud's stepbrother, Pelleas,. who returns her love on the same terms and is slain by the jealous Golaud. Later Melisande dies just after childbirth. Simple enough, yet full of incident.

Maeterlinck's play, which Debussy saw in Paris, immediately appealed to him and, with the author's approval, took three years to compose his first version. He took another three making revisions in almost every scene. One would have thought a Maeterlinck-Debussy collaboration ideal. Instead the two quarreled violently whenever, for the sake of his music, Debussy altered some of the author's scenes. But Debussy knew exactly what he wanted and the result is one of the three greatest operas written this century. The other two? Elektra and Wozzeck.

Debussy once put on record his idea of an ideal poet. "A man who reveals only half his message; who permits me to graft my dreams to his. Whose characters, story and setting are timeless and not restricted to any special location; who will not impose despotically on me a conventional plot and who will leave me free, now and again, to exhibit a greater art than he, and to add finishing touches to his work. He doesn't need to be afraid. I do not intend to make the same mistakes as in the usual lyrical plays in which the music forces itself upon one insolently and which the poetry is relegated to a place of only secondary importance. I dream of a poet who will not condemn me to perpetuate long, slow-moving acts; of poems which will provide me with moving scenes, noteworthy for their constant change of setting and characters; in which the cast does not chatter incessantly but submit to the demand of life and fate."

In his version of the Maeterlinck play, Debussy found — or rather forged — all this to the eternal enrichment of the operatic repertoire — and the fuming indignation of the play's author!

One curious fact has always impressed me. The first Melisande was Mary Garden, an American soprano and, for many years after, it was thought mandatory to cast an English-speaking Melisande, obviously to increase the mystery of her origin. This practice has since been dropped.

Despite Maeterlincks's objections, Debussy succeeded in intensifying the lyricism of the original poetic drama. Each scene is wonderfully different from any other. Each has its own miraculously clear perception of plot and character. I could go on writing for pages about this opera's almost indescribable beauties, its many mysteries, both musical and atmospheric, and one's increasing enjoyment at hearing every repetition.

And, importantly, it is ideal for recording since in this form you can, in imagination, supply your own settings and actions rather than watch a stage performance. This latter statement is not intended to disparage Pelleas as a "real" opera or infer that a stage performance will not be a notable experience to every sensitive musician.

This set was made in 1965 and, despite its age, the playing, singing and atmosphere are as close to perfection as I can imagine. You will find no difficulty in adding to the music a visual entity of your own devising. The singing is fine and completely idiomatic, and the orchestra — not one of the world's best — rises to unusual heights under that great interpreter of Debussy — the late Ernest Ansermet.

☆ ☆ ☆

BRAHMS — Piano Concerto No. 2 in B Minor. Maurizio Pollini (piano) with the Vienna Philharmonic Orchestra conducted by Claudio Abbado. DGG Stereo Cassette 3300 790.

Here is an unusual reading of this great concerto, especially in the first movement. Pollini often interrupts the surging progress of the music by introducing delicate musings. The playing is always beautifully controlled by the reading, daringly different from tradition. This treatment is of course, perfect in the slow movement — one of Brahms' most beautiful. The piano entrance after the longish orchestral introduction never fails to thrill me and I am not ashamed to state that I simply wallow in what follows.

A word here in appreciation of the lovely playing of the solo cello throughout the movement. After having enjoyed this so much, the contrasts in the first movement seem all the more overdone. True there must be contrasts but they must never be allowed to disturb the continuity of the composer's line of thought. As played

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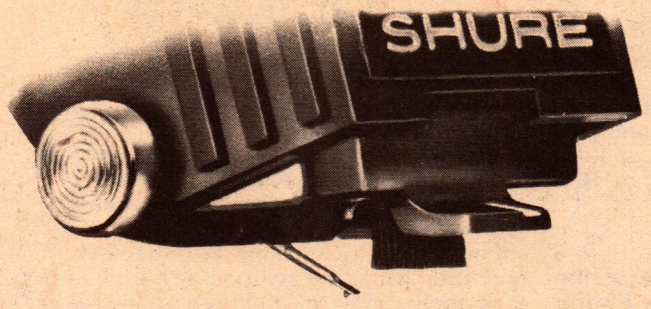

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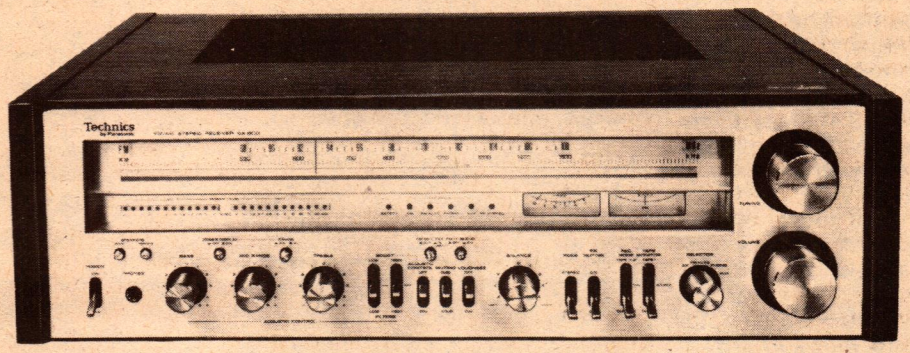

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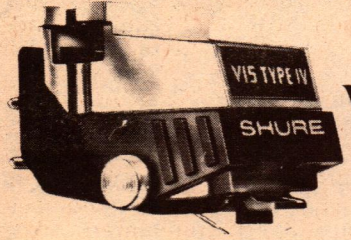

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by Pollini they sound a little like a conflict between two moods.

Nor was I happy about the Scherzo which starts boldly enough but tails off here and there. Absent is Brahms' characteristic rumbustiousness. The finale, too, though played with mellifluous delicacy, might have originated in Paris rather than Hamburg.

In this performance Pollini establishes himself as a pianist of high accomplishments, but they somehow don't fit into the Brahms conception.

☆ ☆ ☆

CHOPIN — Piano Sonatas Nos. 2 in B Flat Minor and No. 3 in B Minor. Nikita Megaloff (piano). Philips Stereo Sonic Series Cassette 7317 188. Complete Waltzes 1-19. Nikita Megaloff (piano). Philips Stereo Sonic Series Cassette 7317 185.

If you are to enjoy the playing on these cassettes, you must be willing to accept three facts which distinguish the performances from those of many competitors'. First there is Megaloff's tendency to over-pedal at times. Either that or, another explanation, they were recorded in an over reverberated hall or studio. Second, you must be prepared for a different approach from the boudoir attitude that many fine players adopt towards Chopin's music. And lastly, don't expect to hear the pearly touch of a Cortot — wrong notes and all — or the aristocratic authority of an Arthur Rubinstein. If you are prepared to make these concessions you will hear much to enjoy.

In the Sonatas you may be further surprised at the lack of characteristic Chopin rubato. Its very occasional use in these works makes them sound a little strait-laced. In both works you will come across passages played with the Chopin touch mentioned above, though the stern omission of rubatos remains.

I must confess to not being happy about what a colleague of Polish origin put to me, at a Roger Woodward recital, regarding the "Warsaw" school of Chopin playing. We know that Chopin was Polish born and that, despite his long absences from that country, he felt strongly patriotic towards it. It is this attitude towards Chopin the patriot on which the present day nationalistic school concentrates.

My argument against this style is that we are close enough in time to Chopin for his style as exemplified by his own playing to have been handed down undistorted by those of his followers very close to him. Hence the Chopin tradition — till recently — a model for those who preceded the "Warsaw" school. This tradition was observed by such great Chopin interpreters as Paderewski, Pachmann, Cortot and Rubinstein.

I deliberately omit the swooning style, with its exaggerated rubatos, of such players as Samson Francois and others like him who stretch the music like a rubber band. But the others mentioned all shared one thing in common — the Chopin touch with its strings of pearly runs and the careful use of rubatos without distortion of the melody. Treated as it is by Megaloff, even the Funeral March movement in the B Flat Sonata sounds just a little bit shallow. And the "graveyard" finale lacks its usual ghostly quality. Perhaps Megaloff's treatment of both Sonatas might add compensatory stature as opposed to that of the earlier school.

And here I must add that there are, all through his Oeuvre, really patriotic outbursts that Chopin intended to sound revolutionary — the "Revolutionary" study for instance, together with some of the Mazurkas and Polonaises. I personally was brought up on the older style and freely admit to being thought a fuddy duddy by the other side.

In the case of the B Minor Sonata, except for the above mentioned resonance I preferred the first movement which conforms more logically to Megaloff's style. And as if to contradict all I have just written Megaloff plays the opening and ending of the second movement with a sensitivity that I found altogether disarming. Indeed I found the whole of this Sonata more enjoyable than the first, despite its rather strait-laced third movement.

You will also find this Megaloff style in the waltzes though here the nature of the material is lighter than in the Sonatas. In these, he is a good deal more generous with his rubatos, though his tone again sounds as assertive as it is in the Sonatas. It is this that removes the customary sparkle from some of them and also some of their elegance. Each item is, however, note perfect at whatever tempo Megaloff is playing.

But those whose ideal style is that of Pachmann-Cortot-Rubinstein will find Megaloff's treatment more masterful than carressing. And here too you will hear the same resonance as in the Sonatas, which may be due to the engineering of the pianist's pedalling.

Those who like to think of Chopin as less dependent on the ministrations of George Sand will find Megaloff's playing entirely to their taste. By the way, there are 19 instead of the usual 14 Waltzes on this cassette, the extra five being later discoveries included in the 1962 Zimmermann edition.

Rachmaninoff: 'very highly recommended'

RACHMANINOFF — Concerto No. 3 in D Minor. Vladimir Horowitz (piano) with the New York Philharmonic Orchestra conducted by Eugene Ormandy. Golden Jubilee Concert recorded at Carnegie Hall, New York, on January 8, 1978. RCA Red Seal Stereo disc CRL1 2633.

Here is a player with a much more alluring touch and an unimpaired technique, although he passed the age of 70 some years ago. His fast passages glide past with never a hint of a stumble. His singing tone in cantabile melodies, his power, when he chooses to exercise it at its full, can still be marvelled at by fine pianists half his age. Indeed, the only quibble I have to make about this superb disc is that, recorded a little forward, he tends to obscure some orchestral passages. This might be attributable to the fact that it was recorded live at Carnegie Hall, New York as recently as January this year — without a single cough from an obviously entranced audience.

This is his third recording of the Rachmaninoff. I didn't hear his first but still have his second and comparison shows that he has done a good deal of rethinking of the score and now presents a deeper conception of the work's stature. As played here, I have no hesitation in placing it among the finest works of its kind, despite the present day fashionable tendency to disparage the composer, himself a great pianist. Moreover, this performance is marked by a freshness and enthusiasm I find quite astonishing at Horowitz' age.

There is, too, the added advantage of splendid co-operation with the New York Philharmonic under Ormandy. Both principals are unrepentant romantics and make the very best use of the composer's luscious writing. The orchestral playing can best be appreciated when the piano is silent, as at the beginning of the second movement when Ormandy produces some of the most sumptuous sounds imaginable.

There are countless alternative versions of this concerto played by a variety of fine artists but I have no hesitation in saying that this one is now my favourite. As a rule, I find the applause at the end of a recorded work is tiresome and at times even hinting at artificiality. But after the music had finished on this disc I felt very much like applauding myself! Very highly recommended.

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Lighter Side

Reviews of other recordings

Devotional Records

RICK POWELL'S SUNDAY CHOIR. Arranged and conducted by Rick Powell. Stereo, Singspiration ZLP-319S. (From S. John Bacon Pty Ltd, 13 Windsor Ave, Mt Waverley 3148. $7.95.)

For this deliberately varied program of devotional music, Rick Powell has intermixed some old favourites with newer hymns, traditional tunes with those with less well known, solo voice, choral and orchestral sound. The result is an eminently listenable program for those who appreciate simple devotional music:

O For A Thousand Tongues — Beloved Let Us Love One Another — It Is Well With My Soul — The Greatest Of These Is Love — Stand Up And Bless The Lord — Saviour Like A Shepherd Lead Us — The Solid Rock — When I Survey — Love Was When — Thou Art Worthy.

Recorded in Indiana, USA and imported from the USA, the recording is well balanced, with good stereo spread and of good average quality. Fine for family Gospel listening. (W.N.W.)

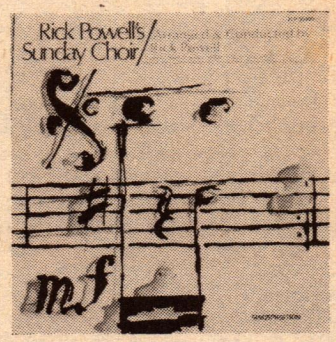
☆ ☆ ☆

I SEE GOD. Jim Nabors. Stereo, Interfusion L-36589. (Festival Release).

I sat down to review this new Jim Nabors album with pleasurable anticipation, remembering the impression he made with his early recordings. But I became progressively let down as side 1 progressed, with a combination of odd vowel sounds and, more seriously, odd off-pitch high notes: I See God — The Lord's Prayer — Will The Circle Be Unbroken — Precious Memories — Love Lifted Me — Ah Sweet Mystery Of Life.

Yet immediately following a disappointing performance of the last-named track, side 2 opened with a copybook rendition of the difficult "The Relative Man". Other tracks were: Shall We Gather At The River — Now The Day Is Over — A Wonderful Time Up There — Bringing In The Sheaves.

Technically, the recording was clean and noise free but I could not add "well balanced". Either the acoustics or the



solo microphone seem to have imparted a middle resonance to the sound which does nothing to help Jim Nabors' voice. All told — just so so! (W.N.W.)

FAVOURITE HYMNS. The Magic Organ. Stereo, Interfusion (Festival) L-25272.

Although I didn't review too kindly the first "Magic Organ" collection of hymn tunes, it has been followed by this second album. Presumably, more people liked Jerry Smith's strict tempo hymn tunes that I would have expected.

On this one, "This World Is Not My Home" sets a cracking pace and comes over well enough in the magic organ formula. But how could any expect similarly to adapt "Whistering Hope"? The same difficulties occur throughout the rest of the program, with some hymns lively enough, but others sounding more like a hep session on the harmonium on Walton's Mountain.

Other track titles are: On Jordan's Stormy Banks — Wonderful Words Of Life — Let The Lower Lights Be Burning — The Lily Of The Valley — The Unclouded Day — The Haven Of Rest — The Ninety And Nine — I Love To Tell The Story — Just A Closer Walk With Three — Shall We Gather At The River.

Technically, the sound off the record is quite clean, as it should be, with no demands being made on dynamic range.

Best you have a listen to a track or two. You may find it anything from tedious to novel. (W.N.W.)

Instrumental, Vocal and Humour

BILLY VAUGHN: A Collection Of Golden Performances. ABC Records ABCA 30019. RCA Release.

A dozen and a half pleasant background tracks is the content of this record with Billy Vaughn's big orchestra. Some of the tracks are: Orange Blossom Special — Melody Of Love — Swingin' Safari — Roses Are Red — Blue Hawaii — Theme From A Summer Place — Days Of Wine And Roses — Moon River — Alfie — Stella By Starlight — Sail, Along Silv'ry Moon.

As you can see, the titles are not exactly today's Top 40. Neither is the performance, being almost "Palm Court" in style, but this should not detract from an easy to listen to record with excellent technical quality. (N.J.M.)

☆ ☆ ☆

ISN'T IT ROMANTIC. The Passadena Roof Orchestra. Stereo, M7 Records MLF-228. Also on cassette MCF-7228.

If it weren't for the modern stereo sound, one might think that this recording had stepped right out of the thirties. This is no accident, however. The Passadena Roof Orchestra plays the music of the twenties and thirties in the style of a ballroom orchestra of the period, complete with matching vocals and in strict dance tempo. They round it out by appearing in white evening suits, bow ties and wing collars. And the music:

Isn't It Romantic — I Won't Dance — I Told Every Little Star — Cheek To Cheek — Hey, Miss Moonlight — Singing In The Rain — Whispering — I'll See You Again — Dream A Little Dream Of Me — Creole Love Call — Soft Shoe Shuffle Blues — Sunday.

According to the jacket notes, the Passadena Roof Orchestra first hit the big time during a visit to Hamburg, Germany, leading to three albums of which this is the most recent. Your reaction to it could range all the way from incredulity to a luvverly fit of nostalgia as you listen to numbers like "I'll See You Again". Best you listen for yourself! (W.N.W.)

☆ ☆ ☆

JAWS 2 (Soundtrack Recording) MCA 3045 Astor Release.

Another one of those big, mammoth, super, colossal and boring disaster movie themes with lots of symphonic pretensions that don't really come off for the non-committed listener. Against this, the quality is extremely good. Perhaps it could find a home somewhere as a demonstration disc! (N.J.M.)

Reviews in this section are by Neville Williams (W.N.W.), Jamieson Rowe (J.R.), Leo Simpson (L.D.S.), Norman Marks (N.J.M.), David Edwards(D.W.E.), Greg Swain (G.S.), and Danny Hooper (D.H.).

AN UNMARRIED WOMAN. Music by Bill Conti from the film. Stereo 20th Century Fox L-36560. Festival release.

In reacting to this album, one faces the dilemma that is frequent with sound track recordings: the knowledge that music, meaningful to those who have seen the film, may be of no significance to those that haven't. Being in the latter group in this case, I could only read the titles and wonder how it all fitted together:

An Unmarried Woman — Ice Skating — In Bed With Charlie — Packing Up — I'm Getting Married — Erica And Saul — Unmarried Woman (Vocal by Michelle Wiley) — Martin's Decision — Chase Me — Loft Party — Erica Leaves Saul.

If you've seen the film, you may be able to supply your own continuity. If you haven't, it'll be just another recording of light, episodic film music, technically okay but un-remarkable, when heard in isolation. (W.N.W.)

☆ ☆ ☆

SHAKTI. John McLaughlin. CBS SPB 234819.

Shakti is another blending of East and West. The advantage this group has is that its Western element is John McLaughlin, master guitarist and musical explorer.

At times the persistent background provided by the Eastern component of the group blends perfectly with the superb guitar work of McLaughlin but, even so, the album would be limited in its appeal.

Tracks include Joy — Lotus Feet — What Need Have I For This — I Am Dancing At The Feet Of My Lord — All Is Bliss, All Is Bliss. (D.W.E.)

☆ ☆ ☆

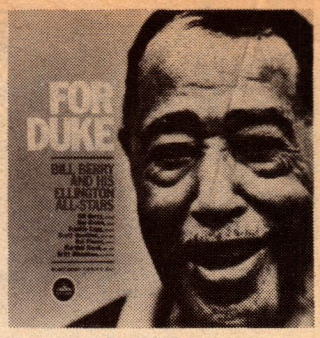
A TRIBUTE TO BING CROSBY. The 101 Strings Orchestra. Stereo, Astor S-5352.

It had been a heavy day and the TV programs were anything but inviting. Hence the request: "Put on a record . . . something relaxing." What more natural to choose to listen to — and review — that this release from the 101 Strings Orchestra playing songs made famous by Bing Crosby?

Too-Ra-Loo-Ra-Loo-Ral — True Love — Just One More Chance — Sweet Leilani — Bells Of St Mary's — Swinging On A Star — Once Upon A Love — Moonlight Becomes You — When Is Again.

As you might imagine, the tunes fitted the mood, with one concession: I had to turn the treble down a bit to take a certain edginess off the strings; you may have to do the same. Playing time is just over 30 minutes. (W.N.W.)

ONE OF THE BEST EVER



FOR DUKE. Bill Berry and his Ellington All-Stars. Stereo, direct to disc, limited edition. M&K Realtime Records RT-101. (From M.R. Acoustics, PO Box 110, Albion, Qld 4010).

In terms of sound quality, this has to be one of the best recordings I have heard in many a long day. It is absolutely clean, with brilliant transients, and not the slightest sign of stress at any dynamic level. And the general balance and stereo definition are equally commendable.

As the title implies, the whole recording is a tribute to the late Duke Ellington, by top-line jazz musicians whose careers have been shaped or influenced by his genius: Bill Berry (cornet); Ray Brown (bass); Frankie Capp (drums); Scott Hamilton (tenor sax); Nat Pierce (piano); Marshal Royal (alto sax); Britt Woodman (trombone).

The track titles: Take The "A" Train — Mood Indigo — Things Ain't What They Used To Be — Perdido — Satin Doll — I Got It Bad (And That Ain't Good) — I Let A Song Go Out Of My Heart — Cotton Tail.

An aspect that impresses is that, despite the tensions that characterise performances for direct-to-disc, there is no sign of them here. The musicians have a ball.

If you dig, or like, or even tolerate jazz — recommended. (W.N.W.)

"Reference" piano album

PIANO. Steven Gordon Plays Chopin. R. R. Reference Recordings, Limited edition, stereo, RR-2. (From M.R. Acoustics, PO Box 110, Albion, Qld.)

According to the jacket, this recording has been made using the patented Pressure Recording Process and with special attention to phase linearity, but I have not yet been able to discover what all that means in practice. It is clear, however, that it was recorded using a simple microphone set-up, a minimum of console electronics and transferred to disc at half-speed, using CD-4 technology.

"Limited edition" signifies that the master tape is used once only for the original transfer to the lacquer, with a limitation placed likewise on the number of "mothers", "stampers" and pressings.

The program is by the Los Angeles-born concert pianist Steven Gordon playing: Scherzo in B-flat minor — Bacarolle in F-sharp, op 60 — Ballade in G-minor, op 23 — Nocturne in C-sharp minor, op 64, no 2 — Etude in C-minor, op 25 no 12. They are very capably played on a 9ft Yamaha grand.

My sample pressing yielded a few dust-like clicks on side 2 but, otherwise, the sound was noise-free and distortion-free even in the loudest passages. In fact, you'd probably search for a long time to find a piano recording which offers more massive sound, yet without any apparent tracking problems — at least with a quality cartridge.

Reference Recordings are produced with the idea of being used as demanding demonstration discs, and this one certainly impresses. (W.N.W.)

SOUND OF A DRUM. Ralph MacDonald. SBP 237122. CBS release.

This album was first released in 1976 but has been circulating again since Ralph MacDonalds' "Calypso Breakdown" appeared on the multi-million dollar selling, double-album "Saturday Night Fever".

"Sound Of A Drum" contains six tracks: Sound Of A Drum — Where Is The Love — The Only Time You Say You Love Me — Jam On The Groove — Mister Magic — Calypso Breakdown.

The track "Where Is The Love" contains vocals while the other five tracks are similar to Calypso Breakdown. If you appreciated Calypso Breakdown on "Saturday Night Fever" then this album may appeal to you, if not, leave it. (D.H.)

☆ ☆ ☆

BERKSHIRE. Wha-Koo. ABC Records. AA 1043. RCA release.

Wha-Koo is: Danny Douma: lead vocals, guitar; David Palmer: lead vocals; Nick van Maarth: lead vocals, guitar; Richard Kosinski: keyboards; Claud Pepper: drums; Don Francisco: vocals, percussion; Peter Frieberger: bass.

This album contains the hit single

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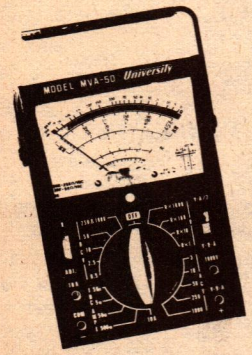

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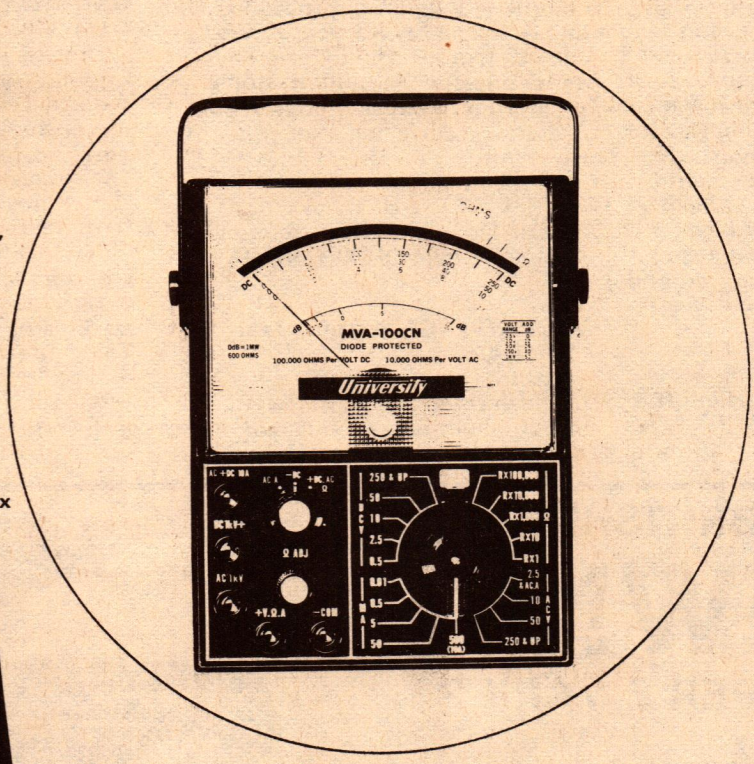

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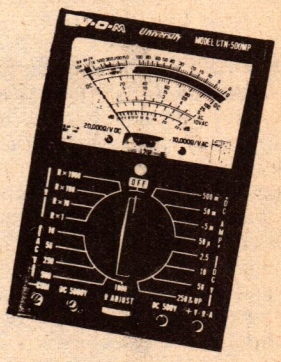

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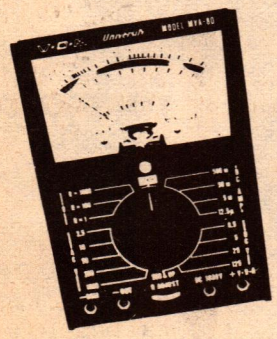

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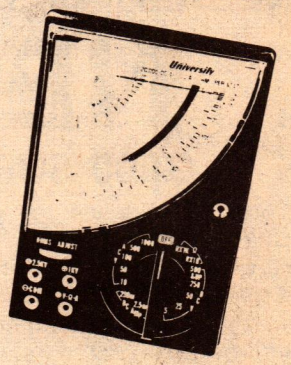

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LIGHTER SIDE — continued

"(You're Such A) Fabulous Dancer" which had a good reception all over Australia. Other tracks of good quality are: Rig-a-Marole — Fat Love — Midnight Kitchen — I'm Here And Dreaming As One.

The album is mainly easy-listening and each of the nine tracks is characterised by clear vocals and strong musical arrangements. (D.H.)

☆ ☆ ☆

WONDERGAP. Wondergap. A & M Records. L 36534. Festival release.

Wondergap is two males: Andy Goldmark (composer, pianist, vocals); Jimmy Ryan (guitars, vocals); and one female: Holly Sherwood (vocals).

This is their debut album for A & M Records, containing 10 original tracks: Give Me One Last Chance — Elise — You Slicky My Heart — Mambo Lady — Sing Hi, Sing Lo — Too Wise — Go On And Take A Bow — I've Never Been So Happy — Isn't It Crazy — Viking.

Vocals and musicals arrangements are fairly enjoyable, revolving around ballads, rhythm & blues and reggae. (D.H.)

☆ ☆ ☆

18 GREATEST HITS. Dolly Parton. RCA Records SP186.

If you're a fan of the Blonde Bombshell, you'll be in for a treat if you buy this record, because it's a beauty. The recording quality is excellent, and the best recommendation I can give you for it is to just list all the tracks.

In order these are: Love Is Like A Butterfly — Jolene — In The Good Old Days — Mama Say A Prayer — Coat Of Many Colours — The Bargain Store — My Tennessee Mountain Home — Touch Your Woman — I Will Always Love You — Travelling Man — Just The Way I Am — In The Ghetto — The Carroll County Accident — Always A First Time — The Harper Valley PTA — All I Can Do — Boulder To Birmingham — Jeanie's Afraid Of The Dark. (D.W.E.)

☆ ☆ ☆

SWEET REVENGE. Amanda Lear. RCA VPL 14076.

Amanda Lear is the Queen of the European Discos, and it follows that her second album is predominantly disco. The first side is comprised of five songs, merged together to form a continuous beat. Included on this first side is a seven-minute version of the single "Follow Me."

Side 2 of the album contains four songs: "Enigma" is disco; "Comics" is rag-time; "The Stud" is a rock 'n' roll number and "Hollywood Flashback" could be categorised as a sentimental ballad.

Amanda Lear has been the centre of controversy, described as a female impersonator. A listen to her "husky" voice on this album will indicate the reason for such contention.

All in all, Sweet Revenge is an excellent release. (D.H.)

☆ ☆ ☆

FIND THE LADY. Trickster. Jet Records UA 36467.

This is the debut album for the English group "Trickster", who have a distinctive British rock sound. A times there are shades of Queen in their music, and sometimes a touch of 10CC. Their music is fresh and energetic, sometimes exciting and always interesting.

Tracks which particularly caught my ear are "Listen To My Music" and "Your Money Or Your Life". Other tracks are: Rich Man — Louise — If That's The Way The Feeling Takes You — The Song Will Always Be The Same — Goodbye '6s' — Let It Lie.

Recording quality was quite good, with little surface noise. (D.W.E.)

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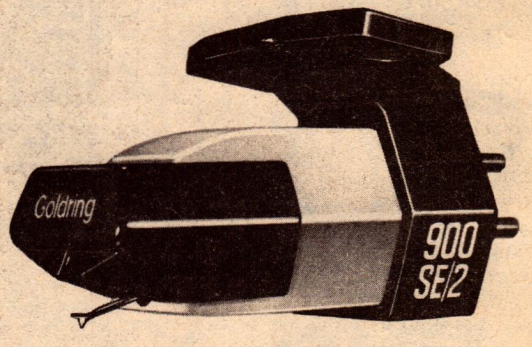

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INVITATION TO LOVE. Ronnie Aldrich & his Two Pianos. World Record Club stereo R03079.

Pianist Ronnie Aldrich plays very much middle-of-the-road music with lively backing from the London Festival Orchestra (and Chorus, on some tracks). Fortunately, the orchestra does not predominate, which is as it should be. Recording quality is good.

There are eleven tracks: Cherish — Gypsies, Tramps & Thieves — Theme from "Summer of '42" — I Want To Teach The World To Sing — Baby, I'm-a Want You — Theme from "The Onedin Line — Theme from "The Go-Between" — I Could Be Happy With You — Imagine — Invitation To Love — Diamonds Are Forever. (L.D.S.)

☆ ☆ ☆

SKYNYRD'S FIRST AND ... LAST. Lynyrd Skynyrd. MCA Records MCA 3047. Astor release.

Lynyrd Skynyrd have now disbanded, and this recording serves as their epitaph. The tracks included on this album give a representative sampling of their unique country-rock style.

The album was recorded in Muscle Shoals between 1970 and 1972, and was the first studio experience for Ronnie Van Zant, Gary Rossington and Allen Collins, the main people behind the distinctive Skynyrd sound. Overall, a fine record, which should be a must for all country-rock fans. Recording quality is good, with little surface noise. (D.W.E.)

☆ ☆ ☆

THE SKIRL O'THE PIPES. Dysart & Dundonald Pipe Band. Lismor Recordings LILP 5051. Astor release.

The Dysart and Dundonald Pipe Band, under Pipe Major R. T. Shepherd, won the Champion of Champions award in both 1974 and 1975, as well as collecting many other minor awards. This record gives a good sampling of their style and talents.

There are eleven tracks in all, comprised mainly of marches in 2/4, 3/4, 4/4, 6/8 and 9/8 time. A drum fanfare is included also, as well as a traditional medley, hornpipes, jigs and waltzes.

Overall, I found this record to be most enjoyable, although I would only recommend it for those with a liking for the bagpipes. Recording quality is excellent. (D.W.E.)

☆ ☆ ☆

WARMER COMMUNICATIONS. The Average White Band. DXL1 3053. RCA release.

Warmer Communications is the first studio LP release of new material since 1976. However, the Average White Band are already a very influential Rhythm & Blues Soul band, with two No. 1 US singles to their credit. It seems strange, after listening to their music, that there is only one black member in the group.

The Average White Band comprises: Hamish Stuart — Guitar and Lead Vocals; Alan Gorrie — Bass and Lead Vocals; Roger Ball — Keyboards, Synthesizer and Alto Sax; Steve Ferrone — Drums and Percussion; Malcolm Duncan — Tenor Sax and Soprano Sax; Onnie McIntyre — Guitar and Background Vocals.

The album would be greatly appreciated by rhythm and blues followers. (D.H.)

☆ ☆ ☆

WHAT DO YOU WANT FROM LIVE. The Tubes. A & M Records. L 45797/8. Festival release.

This is the fourth release from the outrageous San Francisco group The Tubes. "What Do You Want From Live" is a double album recorded live at Hammersmith Odeon, London in November 1977.

The album comes complete with pictures of the groups in concert, showing why they are termed outrageous. Also with the album comes an adhesive sticker stating "certain vulgarities are uttered on the track What Do You Want From Life and between songs on sides 3 and 4."

So be prepared if you do get to listen to this album — it will amaze you. (D.H.)

COMPANY ADDRESSES: Some of the albums reviewed in these columns from time to time are on labels which may not be known to local music shops. In most such cases we include an address from which the albums can be ordered, either direct, or by local record and music supply shops.

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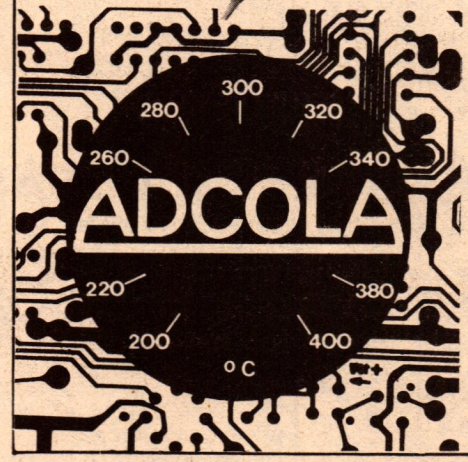

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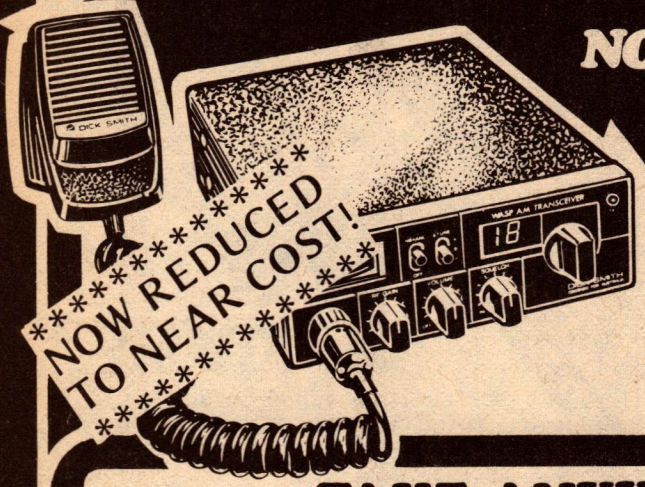

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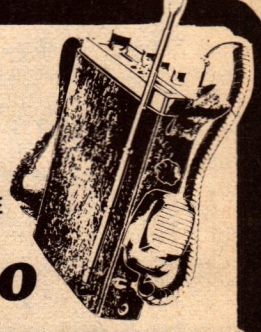

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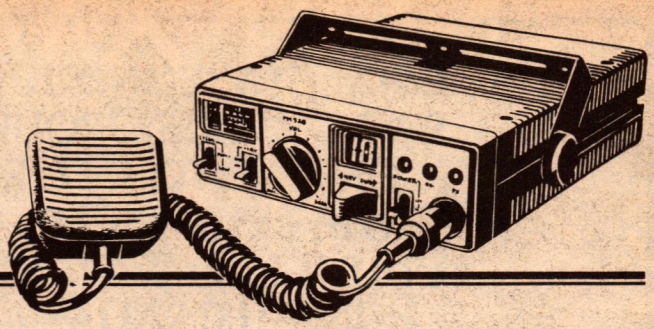


CRYSTALS, SYNTHESISERS AND THE PHASE-LOCKED LOOP — Part 1

Most readers who have scrutinised literature on CB transceivers will have become aware of terms like "crystal control", "frequency synthesiser" and "PLL" ("phase locked loop"). This 2-part article seeks to impart some insight into these terms, without bogging down in a lot of technical detail.

by NEVILLE WILLIAMS

The exact frequency on which a CB transceiver transmits, along with the stability of that frequency, depends primarily on the in-built transmitter oscillator stage. Similarly, assuming superhet circuitry, the frequency to which the receiver is tuned, and the stability of the tuning, is determined by the in-built receiver oscillator.

The abovementioned terms — crystal control, synthesiser and PLL (phase-locked loop) — all describe the nature of the oscillator circuits in a transceiver and therefore represent an important piece of information about its basic design.

In some transceivers, notably those used on the HF amateur bands, the oscillators use inductors and variable capacitors, and are tuneable across certain specific frequency segments. While the tuneable system has its advantages, it also leaves room for error in the choice of frequencies, either because of inadvertence on the part of the operator, or faulty calibration of the tuning mechanism.

Amateur station operators retain the right to use this kind of equipment only because they have demonstrated basic technical skills by examination, and because they have the means to check dial calibrations from time to time.

Virtually without exception, 2-way radio equipment intended for use by (officially) non-technical operators is licensed on the basis of its operation on one or more specific frequency channels, set aside for the class of service and selectable only by a switch. In fact, the equipment has to meet a whole range of official requirements before it can be "type approved" for use on the air at all.

Equipment intended for use for Citizens Band Radio Service falls into this category.

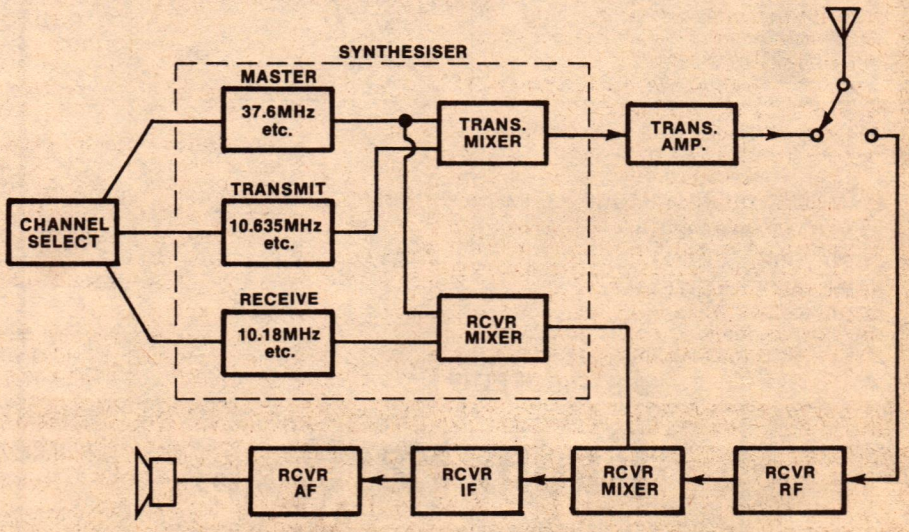
Unfortunately, transmitter and receiver oscillators using ordinary inductance/capacitance circuitry are not sufficiently stable to meet the requirements of a modern 2-way fixed channel system, particularly one operating near or above the top end of the HF band (e.g. at 27MHz or higher).

No matter how carefully the transmitters and receivers were designed and adjusted in the first place, there is every chance, in the course of time, that many transmitters would simply end up outside the selectivity passband of many receivers and not be heard, as a result. With SSB (single sideband) equipment, stability is even more critical, with a drift of even a few hundred hertz being sufficient to render transmissions unintelligible.

For this reason, when a service is planned to operate on one or more specific channels, it is virtually essential that the oscillators determining the transmitted and received frequencies be controlled by precisely ground quartz crystals. This will minimise the risk of transmissions not being heard and, as well, ensure that there will be no off-frequency transmissions to interfere with adjacent services.

Quartz crystals are, in fact, tiny slivers of crystalline quartz which have been very precisely sliced, ground and etched, so that they will oscillate mechanically at an exact nominated frequency, at the same time responding to and producing an equivalent electrical signal.

You've probably came across the appropriate term: the "piezoelectric" effect. It is the same effect which is utilised in (rochelle salt) crystal phono



A typical synthesiser system used in an AM CB transceiver. The significance of the various frequencies is explained in the text. For an AM/SSB transceiver additional provision needs to be made to receive the alternative incoming sidebands.

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The vital point is that, in association with a transistor (or valve) a quartz crystal makes possible an oscillator stage which is both precise and stable in terms of frequency — and relatively simple into the bargain.

The crystal may be ground and etched to generate the required frequency directly, as for example in the 27MHz CB band. Alternatively, the equipment may be designed to use crystals ground for a sub-multiple of the desired frequency, with one or more "frequency multiplier" stages following the basic oscillator. Either way, the precision and stability of the end frequency can be of a very high order.

When a transceiver is required to operate on a single channel, it is logical to provide it with two crystals. The one serving the transmitter will produce, either directly or indirectly, a signal corresponding to the nominated channel frequency. The one serving the receiver will produce a signal displaced by a figure equal to the receiver's first intermediate frequency.

Consider, for example, the CB emergency channel on 27.065MHz; the transmitter oscillator circuitry would ultimately have to provide this frequency. If the first IF of the receiver was, say, 2MHz, the receiver oscillator circuitry would have to generate either 25.06MHz or 29.065MHz. For any other receiver IF (intermediate frequency) a different receiver crystal would, of course, be required.

For a transceiver intended to operate on a number of adjacent channels, an obvious option is to provide pairs of crystals — one pair for each channel — selected by a switch. This was common practice in the early days of CB radio and is still used in many hand-held transceivers covering up to about six channels.

The system has a certain simplistic attraction in that other channels can be selected by simply withdrawing some of the original crystals and substituting others of the required frequency. No great feat of mathematics is necessary to work out what the new crystal frequencies should be!

There is one catch, however, which should be mentioned in this context. The input tuned circuits of the receivers and the output tuned circuits of the transmitter have only a certain bandwidth and this may or may not be enough to accommodate a new frequency well away from those for which the equipment was originally adjusted. By way of illustration, crystals can often be bought to shift a CB transceiver on to the boating frequencies of 27.88, 27.89, etc. However, the performance

of the receiver in particular will often be very poor, unless the input tuned circuits are re-peaked towards the new signal frequencies.

This problem may be less significant in a more elaborate transceiver, designed from the outset to cover a large number of channels. It could reasonably be assumed that the various tuned circuits would have been arranged to cover a broad band.

In fact, the idea of providing separate pairs of crystals becomes very clumsy for more than a few channels — e.g. 46 crystals for the original American 23 channel system — and a quite untenable 80 for the more recent 40-channel system! Quite apart from the cost and space involved, world crystal resources were just not equal to that kind of demand, especially in the face of a booming CB market.

Other approaches had to be developed.

The first such approach produced what is commonly described as a "synthesiser". The scheme was widely used in American 23-channel transceivers designed in the first half of the 70's and, therefore, in many models which appeared on the Australian market at the start of the local CB era.

In the present context — and without being too pedantic — a synthesiser is a system which creates a group of frequencies indirectly by heterodyning other (usually unrelated) frequencies. We have seen the term used in connection with complex communications receivers, multi-channel military transmitters and so on. Here we are thinking of it purely in connection with CB transceivers, most commonly of the type just referred to.

Instead of using 46 separate crystals, each responsible for one distinct frequency, a synthesiser — CB style — used a smaller number of crystals, associated with two or more separate oscillators. These were so arranged that the oscillators would beat, or heterodyne, to create resultants at the specific frequencies needed for the transmitter and receiver. By careful planning, so that each crystal was used several times, the total number required would be considerably less than 46.

Fig. 1 is a block diagram of a typical American CB transceiver for AM operation. The synthesiser section contained a master oscillator served by six crystals generating frequencies 50kHz apart between 37.60MHz and 37.85MHz.

A supplementary transmit oscillator, served by four crystals generated frequencies of 10.635MHz, 10.625MHz, 10.615MHz and 10.595MHz.

A supplementary receiver oscillator,

At a function in the Melbourne Zoo, and with a koala to emphasise the Australian theme, the Minister for Posts and Telegraphs, Mr Staley, presented the Australian Design Award to Philips for 1978, for their FM320 transceiver. Operating in the UHF band, it offers CB facilities free from the hassles of 27MHz.

also served by four crystals, generated frequencies of 10.18MHz, 10.17MHz, 10.16MHz and 10.14MHz.

The channel selector switch, together with the transmit-receive switch, combined these various crystals in pairs to produce the required 46 frequencies, but with only 14 crystals — an obvious saving.

The service data for synthesised transceivers commonly used a graphical display to indicate how the oscillators combine, by virtue of the channel switching, to produce specific resultant frequencies. One set of figures should serve to illustrate how the system works out.

Let's say that the transceiver is switched to American channel 9, equivalent to the emergency CB frequency in Australia: 27.065MHz.

The relevant graph shows that, in the process, the master oscillator would be set to produce 37.700MHz. The transmit oscillator would be set to 10.635MHz; the resultant, produced by subtracting one from the other, would be 27.065MHz, as required.

For receive, the same master oscillator would combine with the receive oscillator on 10.180MHz to produce a resultant on 27.520MHz. This frequency would beat with the incoming signal on 27.065 to produce the receiver IF at 455kHz.

Similar figures could be worked out for the remaining 22 channels.

Other quite different combinations of crystals are possible, even necessary, for different receiver intermediate frequencies, and some synthesisers arrive at the desired resultants by adding, rather than subtracting, the component frequencies. However, the basic principles remain the same.

Again, variations occur with the transceivers designed for AM/SSB operation. Here an additional set of four receive crystals may be provided, offset by say 3kHz, to centre the alternative sideband in the IF selectivity passband of the receiver.

But we are in danger of getting into deep waters. The purpose of the article, to this point, has been to explain how a synthesiser works, with a saving of about 70% in the number of crystals required. Having done that, let's stay clear of the intricacies of SSB!

In a following article, we will have a look at the circuitry which displaced synthesisers: the phase-locked loop.

(To be Continued)

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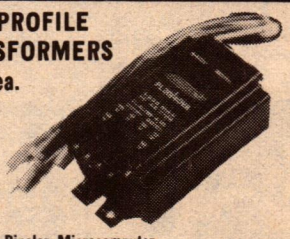

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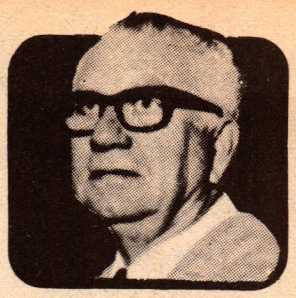
AMATEUR RADIO



by Pierce Healy, VK2APQ

Australian amateur radio club directory

This list is presented to publicize club activities, to give those interested in learning about amateur radio a point of contact, and as a source of information to the community in general.

NEW SOUTH WALES

Club name: AMATEUR & CITIZENS RADIO (VKCB) CLUB.
Club call sign: Prefix "Amateur Radio".
Net frequency: 28.5MHz each Sunday at 8.15pm also first Saturday each month at 7.30pm on 3565kHz.
Contact: Sam Voron, VK2BVS, 2 Griffith Avenue, East Roseville 2069. Telephone (02) 407 1066.

Club name: AUSTRALIAN NATIONAL AMATEUR RADIO TELEPRINTER SOCIETY.
club call sign: VK2TTY.
Net Frequency: 7045kHz; 14.190MHz Sunday mornings at 10.30am.
Contact: Secretary, c/- WIC, 14 Atchison Street, Crows Nest, NSW 2065.

Club name: BLUE MOUNTAINS AMATEUR RADIO CLUB.
Club call sign: VK2AUX, VK2NCM and repeater VK2RBM.
Net frequency: 28.450MHz each Tuesday at 8.00pm, also 146.00MHz FM.
Contact: Secretary BMARC, PO Box 54, Springwood, NSW 2777.

Club name: CASINO AMATEUR RADIO CLUB.
Club call sign: VK2AKB.
Net frequency: Nil.
Contact: R.I. Ashdown, 69 West Street, Casino. Telephone (066) 62 3047. Postal address CARC, PO Box 404, Casino, NSW 2470.

Club name: CENTRAL COAST AMATEUR RADIO CLUB.
Club call sign: VK2EH, VK2AFY and repeater VK2RAG.
Net frequency: Channel 3 FM repeater VK2RAG.
Contact: Secretary Mrs. S.J. Wells, PO Box 238, Gosfrod, NSW 2250.

Club name; CRESTWOOD AMATEUR RADIO CLUB.
club call sign: VK2BFZ.
Net frequency: Nil.
Contact: Bob Lloyd-Jones, VK2YEL, Secretary, 16 Turon Avenue, Baulkham Hills, NSW 2319. Telephone (02) 639 0267.

Club name: FAR SOUTH COAST AMATEUR RADIO CLUB (NSW).
Club call sign: VK2RFS channel 3 FM repeater.
Net frequency: Channel 3 repeater VK2RFS.
Contact: Secretary Ken Kelly, VK2MJ, 9 Hill Street, Merimbula, NSW 2548. Telephone (0649) 51624.

Club name: GOULBURN AMATEUR RADIO SOCIETY.
Club call sign: Nil.
Net frequency: Not stated.
Contact: Secretary, R. Woodman, VK2EY, 38 Dixon St, Goulburn 2580.

Club name: GUNNEDAH & DISTRICT RADIO CLUB.
Club call sign: Nil.
Net frequency: Nil.
Contact: Secretary, GDARC, PO Box 345, Gunnedah, NSW 2380.

Club name: HORNSBY & DISTRICT AMATEUR RADIO CLUB.
Club call sign: VK2APF, channel 13 FM repeater VK2RNS.
Net frequency: 28.4MHz SSB, 147.25MHz FM at 8.00pm on Wednesday evenings. Also slow Morse code on VK2RCW — 147.4MHz.
Contact: Secretary, Kurt Lass, VK2YCU, PO Box 362, Hornsby, NSW 2077. Telephone (02) 47 1426.

Club name: HUNTER BRANCH NSW DIVISION WIA.
Club call sign: VK2AWX and repeater VK2RAN.
Net frequency: 3595kHz each Monday evening at 7.30pm. Channel 6 repeater VK2RAN.
Contact: Secretary Ray Leban, 49 Valaud Crescent, Highfields, NSW 2289, or Bill Hall, VK2XT telephone (049) 59 1586.

Club name: ILLAWARRA AMATEUR RADIO SOCIETY.
Club call sign: VK2AMW and repeater VK2RAW.
Net frequency: 52.525MHz Sunday at 9.30am. 28.460MHz Sunday at 8.00pm. Channel 5 FM repeater VK2RAW.
Contact: Secretary IARC, PO Box 1838, Wollongong, NSW 2500.

Club name: JESMOND & DISTRICT ELECTRONIC & COMMUNICATION CLUB.
Club call sign: Nil.
Net frequency: Nil.
Contact: President Keith Hutchison, 38 Summit Street, North Lambton 2299. Telephone (049) 57 4633. Secretary John Murphy, 103 Rankin Drive, North Lambton 2299. Telephone (049) 57 5560.

Club name: LIVERPOOL & DISTRICT AMATEUR RADIO CLUB.
Club call sign: VK2AZD.
Net frequency: 146.5MHz.
Contact: Athol Tilley, VK2BAD, telephone (02) 72 1107.

Club name: MAITLAND POSTEL INSTITUTE AMATEUR RADIO CLUB.
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Contact: President Reg Wood, VK2RW, 17 Kennedy Street, Rutherford, NSW 2320. Telephone (049) 33 5088.

Club name: MARIST BROTHERS' EASTWOOD RADIO & ELECTRONICS CLUB.
Club call sign VK2ACQ.
Net frequency: 7090kHz and 14.150MHz around 4.00pm.
Contact: Rev. Bro. Cyril Quinlan, PO Box 129, Eastwood, NSW 2122. Telephone (02) 858 1644.

Club name: MID SOUTH COAST AMATEUR RADIO CLUB.

Radio clubs and other organisations, as well as individual amateur operators, are cordially invited to submit news and notes of their activities for inclusion in these columns. Photographs will be published when of sufficient general interest, and where space permits. All material should be sent to Pierce Healy at 69 Taylor Street, Bankstown 2200.

AMATEUR RADIO

Club call sign: VK2RMU channel 2 FM repeater.
Net frequency: 3628kHz Wednesdays at 7.45pm. Channel 2 FM repeater VK2RMU.
Contact: Secretary MSCARC, PO Box 113, Milton, NSW 2538. Telephone (044) 55 1077.

Club name: NORTH WEST AMATEUR RADIO GROUP (NSW).
Club call sign: VK2RAB channel 5 FM repeater at Gunnedah; VK2RMI channel 7 FM repeater at Moree.
Net frequency: 3572kHz each Monday evening at 8.30pm also through repeaters VK2RAB and VK2RMI or 146MHz FM simplex channels.
Contact: Secretary Kerry Adams, VK2BXT PO Box 511, Moree 2400.

Club name: NOVICE AMATEUR RADIO GROUP OF NSW.
Club call sign: VK2BNO.
Net frequency: Nil.
Contact: Secretary, NARG, 14 Atchison Street, Crows Nest 2065 or telephone 457 9158.

Club name: NSW INSTITUTE OF TECHNOLOGY AMATEUR RADIO SOCIETY.
Club call sign: VK2BIT.
Net frequency: Monitor Sydney FM repeaters channel 4 and 8.
Contact: Michael Goard, VK2ZNV, telephone (02) 888 1707. Postal address NSWIT Amateur Radio Society, General office, School of Electrical Engineering, PO Box 123, Broadway, NSW 2007.

Club name: ORANGE & DISTRICT AMATEUR RADIO CLUB.
Club call sign: VK2AOA and repeater VK2RAO.
Net frequency: 3610kHz each Tuesday evening at 8.00pm. Channel 2 FM repeater VK2RAO Sunday evenings at 8.00pm.
Contact: Secretary ODARC, PO Box 1065, Orange NSW 2800.

Club name: OXLEY REGION RADIO CLUB.
Club call sign: VK2BOR and repeater VK2RPM.
Net frequency: Channel 2 FM repeater VK2RPM.
contact: Peter Alexander, VK2PA, telephone (065) 83 2033 daytime. Ian Dalrymple, VK2XU, telephone (065) 83 2175 night.

Club name: PROSPECT COUNTY AMATEUR RADIO GROUP.
Club call sign: Nil.
Net frequency: 28.585MHz Wednesday evening at 7.30pm.
Contact: Secretary, PCARG, PO Box 109, Toongabbie, NSW 2146.

Club name: ST. GEORGE AMATEUR RADIO SOCIETY.
Club call sign: VK2LE and repeater VK2RLE.
Net frequency: 3555kHz Sunday at 8.00am; 14.110MHz Tuesday at 7.30pm; 28.520MHz Tuesday at 8.00pm; channel 4 FM repeater VK2RLE Thursday at 8.00pm.
Contact: President Keith Conolly, VK2NDC, telephone (Bus) (02) 516 3333, (AH) (02) 523 4415. Secretary Jim Button, VK2NPA, telephone (Bus) (02) 531 3295, (AH) (02) 521 7303. Postal address PO Box 77, Penshurst, NSW 2222.

Club name: SOUTHERN HIGHLANDS AMATEUR RADIO SOCIETY.
Club call sign: Application made, also repeater VK2RHR.
Net frequency: Channel 15 repeater VK2RHR.
Contact: President Tim Lee, VK2AOS, telephone (048) 61 1683 (BH). Secretary Kim Orchard, VK2YHC/NAY, telephone (048) 77 1312 (BH) or (048) 61 1683 (AH). Postal address — c/- Telephone Exchange, Bowral, NSW 2576.

Club name: SUMMERLAND AMATEUR RADIO CLUB.
Club call sign: VK2AGH and repeater VK2RIC.
Net frequency: Channel 4 FM repeater VK2RIC.
Contact: Fred Herron, VK2BHE, president; Harold Wright, VK2AWH, secretary. Postal address: PO Box 518, Lismore NSW 2480.

Club name: SYDNEY TECHNICAL COLLEGE AMATEUR RADIO SOCIETY.
Club call sign: VK2BST.
Net frequency: Nil.
Contact: President Arthur Brown, VK2IK; secretary Bill Spedding, VK2NLS. Postal address STCARS, c/- Student Amenities Office, Mary Ann street, Broadway, NSW 2007.

Club name: SYDNEY UNIVERSITY AMATEUR RADIO CLUB.
Club call sign: VK2BSU.
Net frequency: Nil.
Contact: Secretary, Box 398, Wentworth Building, Sydney University, NSW 2006.

Club name: TAREE RADIO CLUB.
Club call sign: Nil.
Net frequency: 28.470MHz, WIA news broadcast and 28.550MHz.
Contact: Geoff Hunziker, VK2BGF, c/- Taree Post Office; Secretary Bruce Cross, VK2YCG/NCK, 22 Crescent Avenue, Taree 2430. Telephone (065) 52 2777 (Bus) or (065) 52 2692 (AH).

Club name: UNIVERSITY OF NSW AMATEUR RADIO SOCIETY.
Club call sign: VK2BUV.
Net frequency: 2 metre FM repeaters channels 4 and 8.
Contact: Christo Simeonoff, VK2ZAX, UNSWARS, Union Box 56, PO Box 1, Kensington 2033.

Club name: WAGGA AMATEUR RADIO CLUB.
Club call sign: VK2WG, VK2NWG and repeater VK2RWG.
Net frequency: Channel 3 FM repeater VK2RWG.
Contact: Secretary WARC, PO Box 71, Kooringal, Wagga 2650.

Club name: WESTERN SUBURBS RADIO CLUB.
Club call sign: VK2BWS.
Net frequency: Nil.
Contact: Secretary, PO Box 336, Fairfield, NSW 2165. Telephone (02) 632 8145.

Club name: WESTLAKES RADIO CLUB.
Club call sign: VK2ATZ and repeater

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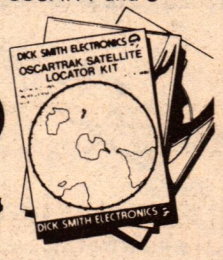

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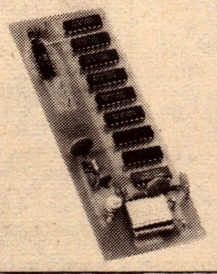

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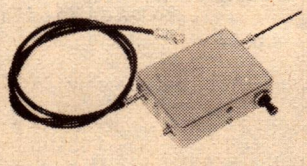

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Net frequency: 3620kHz Friday evenings at 6.45pm.
Contact: Secretary Eric Brockbank, VK2ZOP, PO Box 1, Teralba, NSW 2284. Club telephone (049) 58 1588.

VICTORIA

Club name: AUSTRALIAN LADIES AMATEUR RADIO ASSOCIATION.
Club call sign: Nil.
Net frequency: 3650kHz each Monday at 8.00pm; 3562kHz each Thursday at 8.00pm.
Contact: ALARA, c/- 412 Brunswick Street, Fitzroy, Vic. 3065.

Club name: EASTERN & MOUNTAIN DISTRICT RADIO CLUB.
Club call sign: VK3ER and VK3BNW.
Net frequency: 3570kHz each Wednesday night at 8.00pm, call sign VK3ER. 28.480MHz each Sunday morning at 11.30am, call sign VK3BNW.
Contact: President Tony King, VK3IO or Secretary Graeme White, VK3ZWG. Postal address PO Box 87, Mitcham, Vic. 3132.

WIRELESS INSTITUTE ADDRESSES

Wireless Institute of Australia — Federal Executive, 2/517 Toorak Road, Toorak, Victoria. Telephone (03) 24 8652. Postal address: PO Box 150, Toorak, Vic. 3142.

Australian Capital Territory Division — PO Box 1173, Canberra, ACT 2601.

New South Wales Division — Wireless Institute Centre, 14 Atchison Street, Crows Nest, NSW 2065.

Victorian Division — 412 Brunswick Street, Fitzroy, Vic. 3062.

Queensland Division — GPO Box 638, Brisbane, Qld 4001.

South Australian Division — GPO Box 1234K, Adelaide, SA 5001.

Western Australian Division — GPO Box N1002, Perth, WA 6001.

Tasmanian Division — GPO Box 869J, Hobart, Tas. 7001.

Club name: GEELONG AMATEUR RADIO-TV CLUB.
Club call sign: VK3ATL and repeater VK3RGL.
Net frequency: Channel 8 FM repeater VK3RGL.
Contact: Secretary PO Box 520, Geelong, Vic. 3220. Telephone (052) 9 4261.

Club name: MIDLAND ZONE WIA VICTORIAN DIVISION.
Club call sign: VK3RAM channel 4 FM repeater.
Net frequency: Repeater channel 4 VK3RAM.
Contact: Secretary, Bill Clark, VK2FY, High Street, Kangaroo Flat, Vic. 3555.

AMATEUR RADIO

Telephone (054) 47 7274. Or Bob Lukeis, VK3BRL, c/- PO Eaglehawk, Vic. 3556.

Club name: MOORABBIN & DISTRICT RADIO CLUB.
Club call sign: VK3APC.
Net frequency: Nil.
Contact: Secretary, Glen Percy, VK3ZQP/NRO, PO Box 88, East Bentleigh, Vic. 3165.

Club name: SWAN HILL & DISTRICT RADIO CLUB.
Club call sign: VK3BSH and channel 6 repeater VK3RSH.
Net frequency: Channel 6 FM repeater VK3RSH.
Contact: Secretary Peter Forbes, VK3QI, PO Box 682, Swan Hill.

Club name: THE GIPPSLAND GATE RADIO CLUB.
Club call sign: VK3BJA.
Net frequency: Channel 50 2 metre FM Sunday at 7.20pm; 3560kHz Sunday at 8.00pm; 28.4MHz Sunday at 12 noon.
Contact: Lionel Curling, VK3NM telephone (03) 88 3710.

Club name: WESTERN SUBURBS RADIO CLUB (VIC).
Club call sign: VK3AWS.
Net frequency: 28.470MHz at 8.00pm alternate Tuesdays.
Contact: Secretary Stan Taylor, VK3NGH, telephone (03) 460 5299.

QUEENSLAND

Club name: BRISBANE NORTH RADIO CLUB.
Club call sign: Application for VK4WIN.
Contact: Geoff Adcock, VK4AG telephone (07) 59 7332. Postal address — Brisbane North Radio Club, PO Box 78, Chermside 4032.

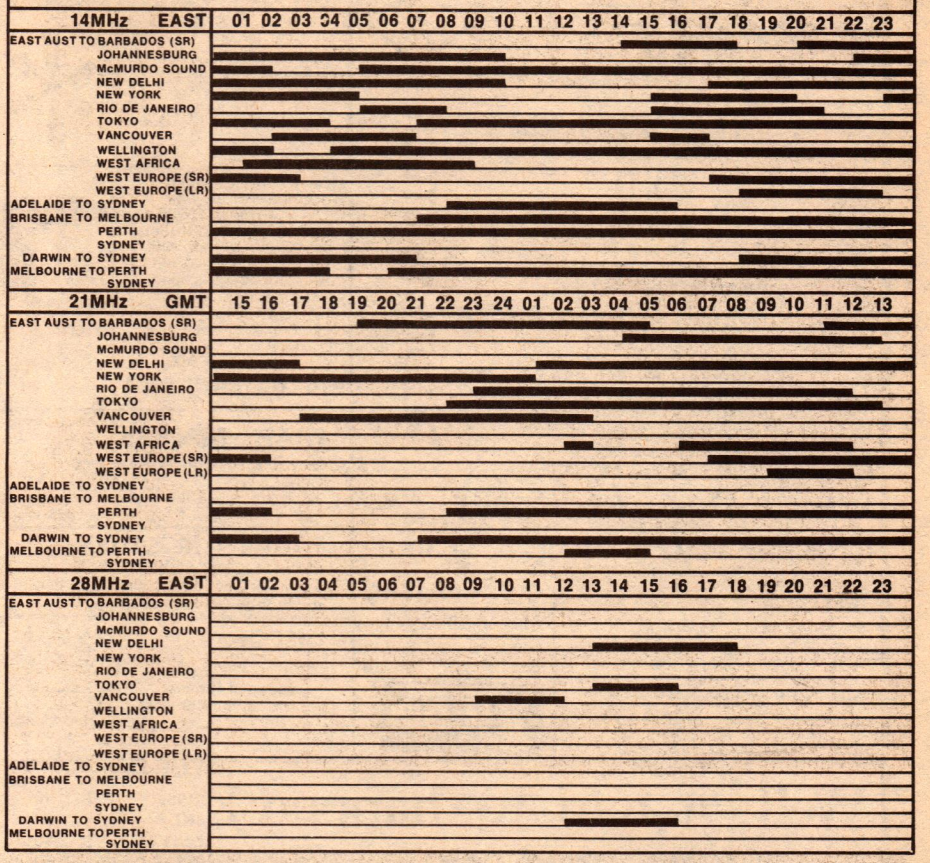
Club name: CAIRNS AMATEUR RADIO CLUB.
Club call sign: VK4HM.
Net frequency: 146.5MHz FM (channel 50). Also HF, Sunday 9.30—11.00am.
Contact: Ron Petrich, VK4ACZ, 22 Amethyst Street, Cairns, Qld 4870. Or Secretary CARC, PO Box 1426, Cairns, Qld 4870.

Club name: GOLD COAST AMATEUR RADIO SOCIETY.
Club call sign: VK4WIG and repeater VK4RGC.
Net frequency: 3570kHz Sunday nights at 8.00pm. Channel 2 FM repeater VK4RGC every morning at 8.00am and Sunday evenings at 7.30pm.
Contact: Secretary GCARC, PO Box 588, Southport, Qld 4215.

Club name: TOWNSVILLE AMATEUR RADIO CLUB.
Club call sign: VK4WIT and repeater VK4RAT.
Net frequency: 3605kHz Sunday evening at 8.00pm also channel 2 FM repeater VK4RAT daily.
Contact: Secretary, Townsville Amateur Radio Club, PO Box 964, GPO, Townsville, Qld 4810.

IONOSPHERIC PREDICTIONS FOR DECEMBER

Reproduced below are radio propagation graphs based on information supplied by the Ionospheric Prediction Service Division of the Department of Science. The graphs are based on the limits set by the MUF (Maximum Usable Frequency) and the ALF (Absorption Limiting Frequency). Black bands indicate periods when circuit is open. 12.78



SOUTH AUSTRALIA

Club name: SOUTH-EAST RADIO GROUP.
Club call sign: VK5SR and repeater VK5RMG.
Net frequency: Channel 6 FM repeater VK5RGM.
contact: Secretary, PO Box 1103, Mount Gambier, SA 5290.

WESTERN AUSTRALIA

Club name: WEST AUSTRALIA INSTITUTE OF TECHNOLOGY RADIO CLUB.
Club call sign: VK6PD.
Net frequency: Nil.
Contact: Secretary, WAIT Radio Club, c/- Box 35, Student Guild, Hayman Road, Bentley, WA 6102.

Club name: WEST AUSTRALIAN VHF GROUP (INC).
Club call sign: VK6WH and VK6VF/P.
Net frequency: All two metre FM channels monitored.
Affiliation: Not stated.
Contact: Telephone David Laws, VK6DS (09) 64 1558. Postal PO Box 189, Applecross, WA 6153.

NORTHERN TERRITORY

Club name: DARWIN AMATEUR RADIO CLUB.
Club call sign: VK8DA and VK8VF.
Net frequency: 146.5MHz; 52.050MHz; 7078kHz; 3555kHz (CW) and 3565kHz (AM).
Contact: Secretary DARC, PO Box 1418, Darwin, NT 5794.

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BS-8	PAN ADAPTER FOR TS520 SERIES
TL922	LINEAR AMPLIFIER
SP520	MATCHING SPEAKER TS520S
SP820	MATCHING SPEAKER TS820S
DG5	DIGITAL DISPLAY TS520
DS-1A	DC/DC CONVERTER TS820
HC-2	WORLD CLOCK 24 HOUR
MC-10	HAND MIC, HIGH Z
MC-35S	HAND MIC, NOISE CANCELLING
MC-50	DESK MIC, HIGH/LOW Z
TS-120V	HF MOBILE TRANSCEIVER
PS-20	AC POWER SUPPLY FOR ABOVE
R-300	COMMUNICATIONS RECEIVER
R-820	COMMUNICATIONS RECEIVER
VFO520S	REMOTE VFO TS520S
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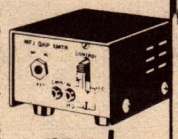

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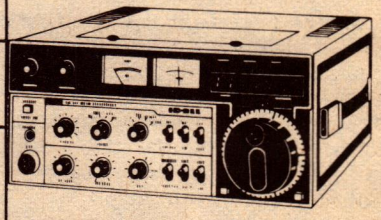

ICOM IC-211 2m transceiver

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IC402	70 cm ssb portable	$469.00
IC202S	2m ssb portable USB/LSB	$357.00
IC202E	2m ssb portable	$239.00

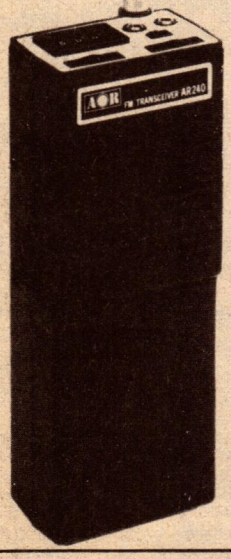
ACCESSORIES FOR THE PORTABLES

LC025	Leather case	$12.00
FA-1	Rubber ducky antenna	$12.00
MMB-B	Mobile mount	$22.00
BC-20	Nicad pack	$69.00

Well, it had to happen !

2m hand-held 800ch Synthesised

144–148 MHz Palm size



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RF output power	: 1.5w
Harmonics	: –60 dB
Spurious	: –70 dB
Repeater offset	: +600 KHz or –600 KHz
Sensitivity	: 0.3 uV 20 dB SINAD

The unit features high quality construction with double sided glass-epoxy pcbs.

And your new hand held comes complete with VICOM 90 day warranty and service back-up.

$399.

1.5w WOW

NEW!

ICOM 2M FM **IC-22S**

The famous IC22S transceiver – more of these sold in Australia than any other 2m Rig. Price: $330.00

2m mobile

IC-280

The popular remotable 2m fm Rig. Price: $450.00

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Gold Coast	32-2644	Hobart	43-6337
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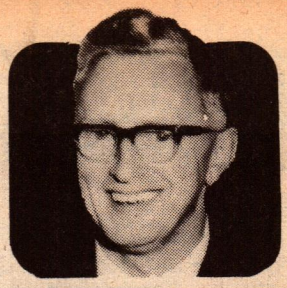
SHORTWAVE SCENE



by Arthur Cushen, MBE

New relay base opens on Sri Lanka

Sri Lanka has, for many years, been the site of a relay base operated by the Voice of America. More recently, a station built by Trans World Radio has been put into service in Sri Lanka, while Deutsche Welle is negotiating for the establishment of a similar relay station.

The Voice of America transmitting station has been in operation for many years and consists of three transmitters, each of 35kW, relaying the VOA programs to South Asia. An arrangement has been made with the Sri Lanka Broadcasting Corporation to use the facilities when not operated by VOA. The transmitters are located at Ekala which is also the site of the transmitters of the Sri Lanka Broadcasting Corporation.

The latest facility to commence operation is that of Trans World Radio and their transmitter operates on medium-wave on 890kHz. The SLBC will have use of the transmitter from 7am-7pm local time, while for the rest of the day the transmitters will carry Gospel programs for Trans World Radio. The station is located at Puttalam and has a power of 400kW.

A third facility is now in the planning stages with the announcement that Deutsche Welle, the Voice of Germany, plans to install facilities in Sri Lanka. The German Government is making negotiations after receiving permission in principle to have a station there, according to Victor Goonetilleke. It is expected that details of the transmitter, location and plans for opening will be announced shortly.

Sri Lanka is unique in the fact that in the future it will accommodate four broadcasting organisations, including the SLBC. The only other concentrated area at the moment is Bonaire which houses Radio Nederland and Trans World Radio relay bases, but there are many other countries and island groups which are being used as bases for foreign short-wave installations.

TURKEY'S NEW OUTLETS

Four frequencies have recently been used by the Voice of Turkey at 2130GMT for their English broadcast, following the addition of two 250kW transmitters to their transmitting facilities. The first transmissions were confined to two bands and used 7170, 7270, 9515 and 9665kHz. The service has since been extended to cover four bands and is now heard on 6185, 7170, 9515 and 11955kHz. The broadcast in English is 2130-2255GMT and is well received on 11955kHz up to 2200GMT, but after this time there is some interference from the BBC.

4VEH RETURNS

After a silence of many months on short-wave radio, station 4VEH at Cape Haitien has recommenced operations on short-wave. The station is using three frequencies: 6120, 9770 and 11835kHz. Reception in this area on 11835kHz has been possible after 1130GMT when Colombo leaves the frequency.

4VEH is a Gospel Station and has been heard in this area as far back as 1950. Our first verification from 4VEH was for reception in June, 1950 when the station operated on 9884kHz with the power of 300W. 4VEH was operated by the East and West Indies Bible Mission from its studios at Cape Haitien in Haiti. Prior to 1950 the station was assigned the "HH" prefix to its call.

NEW AWR CHANNEL

Adventist World Radio, which uses the transmitting facilities of the trans Europe station at Sines in Portugal, has moved from 9670 to 9665kHz. The station broadcasts on Sunday 0600-1000GMT. The first three hours are in continental European languages, with English from 0900 and the World DX Club program at 0930GMT.

Another Adventist World Radio program, this one over the Sri Lanka Broadcasting Corporation and known as Radio Monitors International (with Adrian Peterson), has recently been extended from 15 to 30 minutes in length. The broadcast is now heard on Monday at 1100GMT on 11835kHz, and gives good reception in this area.

RADIO NEW ZEALAND SCHEDULE

New Zealand is now on daylight saving time and, as the short-wave service is a relay of the home program, this means that listeners in Australia and the South Pacific will hear programs one hour earlier than before.

The broadcasting schedule has also been adjusted to cover the change of time and this schedule is in effect to the first Sunday in March.

Pacific Service

GMT	kHz
1700-2005	11960
2015-0415	17770 or 17860
0425-0715	11945
1700-0145	15345
0200-0530	15280
0540-0950	6105
Australian Service	
0730-1115	6105

RED CROSS EXPANSION

The International Committee of the Red Cross at Geneva has carried out test broadcasts on a bi-monthly basis using the facilities of the Swiss Broadcasting Corporation or Swiss Radio International as it is now known. As from this month the broadcasts from the Red Cross are to be monthly and carried on three days. The schedule is 0600-0700, 1130-1230, 1700-1800 and 2200-2300 on 7210kHz.

English is broadcast on Monday with the next transmission scheduled for December 25. The broadcasts on Wednesdays are in French and German and on Friday in Spanish and Arabic. The BBC normally operates on 7210kHz, but will stand by for the period of this test transmission in order

Notes from readers should be sent to Arthur Cushen, 212 Earn Street, Invercargill, NZ. All times are GMT. Add 8 hours for WAST, 10 hours for EAST and 12 hours for NZT. In areas observing daylight time it is necessary to add one hour.

SHORTWAVE SCENE

to allow the Red Cross to evaluate the coverage of the transmission which, in time of disaster, would be used to broadcast messages and other Red Cross information.

NEW KOREAN CHANNEL

Radio Korea at Seoul is using the out-of-band channel of 9870kHz at 0530GMT with a broadcast in English to Europe. Other frequencies have been employed by Radio Korea for their English service which is broadcast for 30 minutes at the following times: to North America 0630GMT on 9640kHz, 1600 on 9640 and 9740, 1800 on 9720, 2000 on 11860; to Latin America 1000 on 9580; to Europe 0530 on 9870, 1330 on 9870 and 11965, 2000 on 7550, 2300 on 7550 and 9640; and the Middle East 1600 on 7550. The General Service is broadcast 0830 on 9525, 1130 on 7275 and 1600 on 7275.

1979 HANDBOOK

The recent frequency change of all stations on medium-wave in Europe, Africa, Asia and the Pacific has resulted in radio listeners searching for a complete list of these changes.

The 1979 World Radio and Television Handbook, which is to be released in February, will include all this information as well as the usual up-date of information on all the world's radio and television stations. The new edition will be airmailed direct to the writer from Denmark as soon as it is printed. Those readers wishing to obtain a copy should contact the writer at the address listed at the bottom of page 121.

NICARAGUA TESTING

Radio Nacional at Managua, Nicaragua has been testing with a new 50kW transmitter over the past few weeks on 5950kHz. Some years ago the station was heard on 5935kHz and verified reception with a letter and a large pennant.

The present test transmissions are well received around 0700GMT onwards with announcements in Spanish after every second recording.

ANOTHER OFF-SHORE STATION

The recent outlawing of stations broadcasting off the coast of countries in Europe has resulted in few remaining on the air. The Voice of Peace, which broadcasts off the coast of Israel, is the only remaining station reported operating on a regular basis.

According to a recent broadcast from Helsinki, a British group is to commence operation this month from a ship with programs for reception in the Scandinavian area. The BBC Monitoring Service reports that the station would be set up on a Dutch vessel sailing under the Panamanian flag in the sound between Denmark and Sweden. It planned to broadcast for 20 hours per day to Denmark, Finland, the Federal Republic of Germany, Sweden and Norway. Programs would consist chiefly of music, advertisements and news.

MOSCOW WORLD SERVICE

Radio Moscow has recently introduced a new world service in English from 0400-1600 and 2100-2300GMT. This has replaced the former regional service to various parts of the world, except to North America.

Listeners in Australia and New Zealand can receive very good signals from Radio Moscow in the 13, 16 and 19 metre bands during the evening, with 21600kHz being the most reliable. According to the BBC Monitoring Service a DX program is heard on Mondays at 0810GMT. The transmissions consist of news on the hour, with news headlines on the half-hour. The balance of the program is generally devoted to music and comments. This new world service from Radio Moscow is on the air for 14 hours a day, unlike the BBC World Service which operates around the clock.

TAIWAN EXTENDS SERVICE

According to a letter from the President of the Voice of Free China in Taipeh the station is undergoing program changes which will increase audience interest and improve program format. The President of the Voice of Free China reports that in the past year the station received 73,794 letters from listeners throughout the world and is confident that this number will double with the new-look that the station plans to adopt.

The Voice of Free China is broadcasting to Australia and New Zealand 2145-2245GMT on 9685, 11825 and 17890kHz. In addition the unannounced frequency of 15225kHz has also been heard.

AUSTRALIA'S NEW FREQUENCIES

Radio Australia is using six new frequencies in its present schedule which is valid up to March 4. Broadcasts from Radio Australia are now carried on the new channels of 6060kHz 1530-2030GMT; 6120 1030-2030; 11800 1745-2000; 11865 1500-1730; 15105 1015-1530 and 15130 0030-0130. The popular Club Forum program is broadcast on Friday at 2040GMT and can again be heard on Saturday at 0840. This session includes some DX information.

COLOMBIAN NEWS

Radio Nacional at Bagota has been noted opening at 0940GMT on the unannounced frequency of 9655kHz. The station gives its usual outlets of 4955, 4975, 6030, 9635 and 1532kHz, according to Tetsuya Hirahara reporting in ADXN. The Colombian station Radio Melodia, operating on 6140kHz, has verified Robert Yeo of North Balwyn, Victoria (reporting in "ADXN"). The station verified in 14 weeks with a letter, car sticker and badge.

LISTENING BRIEFS

EUROPE

BELGIUM: Brussels has been heard on the new frequency of 9645kHz opening in Dutch at 0430GMT. This is a relay of the home program. The transmission time is actually 0430-9615GMT, while from 0630-0715 the broadcast is carried on 11790 and 15190kHz.

GREECE: The latest schedule from Athens shows that the broadcasts to Australia up to March 4 are as follows: 0900-0950GMT on 9655 and 15160kHz; 2100-2150 on 9655 and 9760; 2200-2250 on 9655. A broadcast to Europe 1900-1950 is now on 5955kHz in Greek, English, French and German.

SWITZERLAND: Swiss Radio International is using further frequencies in the 13 metre band, including 21630 at 1315 to North America, while the transmission in SSB is now on 21545kHz. Another channel, 21570kHz, broadcasts in English at 1350GMT.

ASIA

BHUTAN: Signals from the tiny country of Bhutan, a state in the Eastern Himalayas, continue to be heard on two frequencies. In Calcutta, the first transmission on Sundays at 0730-0930 is received on 7040 in place of 7099kHz. According to "DX Digest of India" broadcasts from Radio NYAB are also received on Wednesdays 1230-1330GMT on 4690kHz. This latter frequency gives the best reception in Australia.

INDIA: All India Radio, with the general service in English, is broadcasting to Europe and Africa 1745-1945GMT on some new frequencies. The transmission is now carried on 9525, 9715, 11620, 15125 and 15165kHz. The broadcast to Australia and New Zealand is 1000-1100GMT on 11775, 15205 and 17705kHz. Another service is on 9535, 9912 and 11740kHz from 2045-2230GMT.

PHILIPPINES: The Far East Broadcasting Company at Manila is celebrating its 30th Anniversary and has issued a special verification card and pennant to honour the occasion. The FEBC is still well received on 21515kHz at 0100GMT in its service to Australia and again at 0845GMT is noted on 11765kHz.

LEBANON: A report in "Sweden Calling DXers" states that a new station called the Voice of United Lebanon is to go on air. A 100kW medium-wave transmitter is to cover North Africa, while a short-wave transmitter will be directed towards the USA, South America and Australia. The transmitter is to be located in Ehden, in northern Lebanon.

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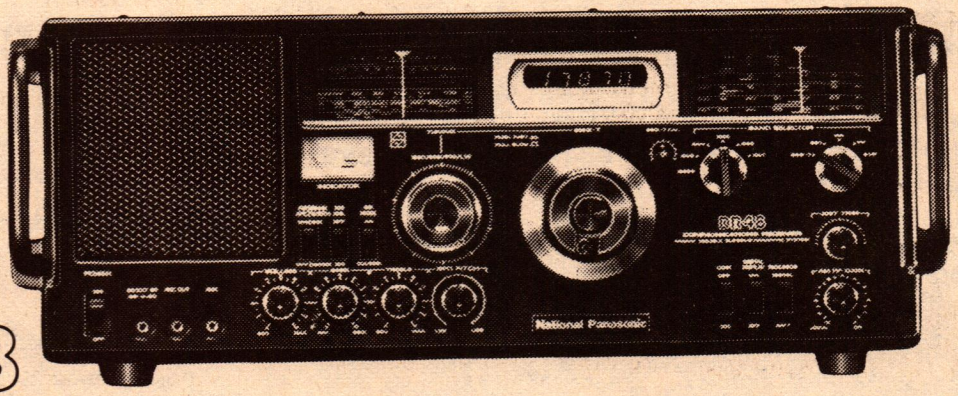

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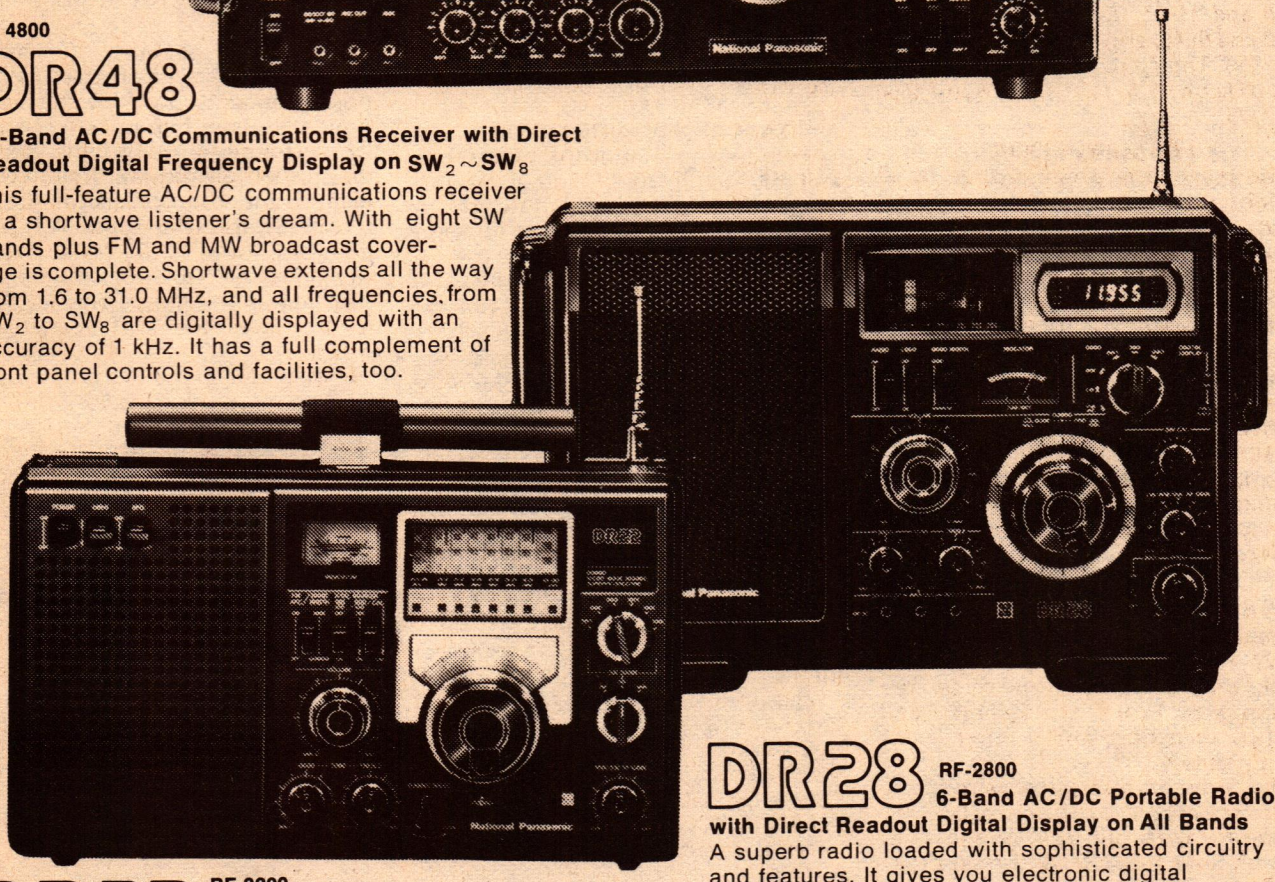

DR22

RF-2200

8-Band AC/DC Portable Radio with Direct Readout Mechanism

Here is a professionally equipped radio with six SW bands plus FM and MW. It features a frequency-linear dial and a sophisticated all-gear drive tuning mechanism. You also get a band spread dial divided into 10 kHz intervals with eight marker points for accurate use with the unit's 125kHz/500kHz crystal marker switches. There's also a BFO switch and a wide/narrow bandwidth selector for crystal clear reception.

DR28

RF-2800

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National DR series

NP2

New Products

Fairchild's Video Entertainment System

The Fairchild Channel F Video Entertainment System is the first of a new generation of video games to be released in Australia. It is based around the Fairchild F8 microprocessor system, and features a multiplicity of intriguing games — many of which require a lot of skill. A standard colour TV set is used as the display/playground/battlefield.

The basic unit consists of a black plastic box, about 300 x 320 x 80mm. This contains all of the control circuitry, including the microprocessor, as well as the video generation circuitry. Screen effects can be generated in three colours, and on-screen digital scoring and elapsed time indicators are provided.

This basic unit contains only two games, hockey and tennis. A row of switches along the front of the unit selects the various available options, such as ball speed and time of play. A reset button and power on/off switch are also provided. A certain amount of skill and experience is required to master these two games, which can also be played in practice versions, against the machine.

Two hand controls are provided, enabling one or two player games to be played. Each controller has eight different movements: left, right, back, forward, twist right, twist left, pull up and push down. A fair degree of practice is required in the use of these controllers, before the separate hand actions can be fully mastered. This, of course, adds tremendously to the fun of the games.

The real versatility of the Channel F centre only becomes apparent however, when one of the many Videocart game cartridges is inserted.

These consist of yellow plastic cases, approximately the size of eight-track cartridge cases, containing a small circuit board and appropriately coded ROMs (read only memories). Each cartridge allows at least one extra game to be played, with some cartridges providing up to four games.

The cartridges are inserted into a slot in the front of the main game case, and the appropriate games and/or options selected by means of the front panel switches. The scope and facilities provided by these cartridges are best explained by listing the contents of some of the cartridges.

The first cartridge of interest is the Democart. This explains the operations and uses of the various controls and switches, as well as giving detailed explanations of the operation of the hand controllers. The explanations are referenced to the game of hockey, which can also be played.

Videocart-1 contains four games, Tic-Tac-Toe (noughts and crosses), Shooting gallery, Doodle and Quadradoodle. Tic-Tac-Toe is played against the machine, which always takes second move (this means you can force a win).

Shooting gallery is again a one person game, in which you try to shoot down ducks provided by the machine. Doodle is a game limited only by your imagination. A colourful pattern can be produced on the TV screen, by your movements of the hand controller. In Quadra-doodle the machine takes over from you, and produces colourful random doodles all by itself. It's almost like watching goldfish — fascinating!

Videocart-2 provides two games, Desert Fox, in which two tanks manoeuvre about a battlefield and attempt to shell each other whilst avoiding mines, and another version of Shooting gallery. Videocart-3 provides one and two person games of Blackjack.

Videocart-4 provides one and two person versions of Spitfire. Here the object is to shoot down your opponent's plane before he shoots you. (Some interesting dog fights occurred in our lab. while we tried out this game!) Videocart-5 provides an interesting version of Space War.

Videocarts 6 and 7 provide mathematical quizzes. The machine puts either addition, subtraction, multiplication or division examples on the screen, and you have to work out the correct answers. The player signifies the answers to the machine by appropriate movements of his hand control.

The eighth cartridge provides two number games, Nim and Mind Reader. With Nim, the object is to remove counters from three piles in such a way that the machine or player takes the last counter, and in so doing, wins. With Mind Reader, you have to guess a mystery number generated by the machine.

Cartridge-9 provides a two player "drag race" game. The object here is to

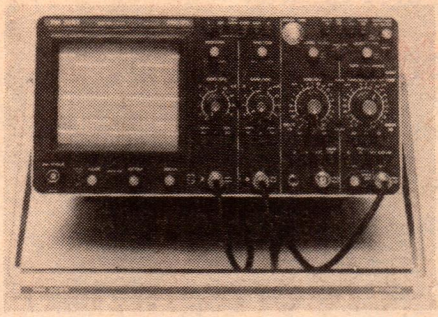
100MHz dual-trace oscilloscope

A compact dual-channel 100MHz oscilloscope has been introduced by Phillips Test & Measuring Instruments. Known as PM3262 this oscilloscope is said to be unique in providing both trigger-view and alternative timebase operating modes. In addition, the new PM3262 features a 5mV sensitivity over the full bandwidth, with 2mV sensitivity up to 35MHz.

Triggering to over 200MHz and the provision of two external trigger sensitivity settings — "standard" and "divide by 10" — enables this oscilloscope to meet the majority of ECL, TTL and other logic measurement needs.

The availability of an alternate timebase mode and the facility to display the trigger channel is of considerable value when examining details of pulse trains and other complex waveforms. The trigger-view channel allows exact triggering conditions to be displayed and so allows direct comparisons between trigger and signal. This is particularly useful for such applications as computer or other digital equipment servicing where triggering depends on a clock pulse and relationships between clock and information are important.

The dynamic range of Ext Trig has been increased by employing a two



position attenuator. The trigger-view channel now features a 1V/div setting, ideal for TTL levels and a 100mV/div position for high speed current mode logic.

An additional facility is the provision of an external Z modulation input at the rear of the instrument. This allows the oscilloscope to function with logic analyzers.

The PM3262 features a logical front panel layout for ease of use. Dimensions of the oscilloscope are a compact 316 x 154 x 410mm and its weight is 9.6kg.

Operation is possible from a wide range of AC and DC supplies and an optional battery pack is available for field applications. Power consumption is only 45W and running time from the battery is three hours.

Video Entertainment Centre . . .

beat your opponent to the finishing line, without blowing your motor, going through a red light, or stalling. Realistic gar changes are included in this game.

Videocart-10 provides four maze games. Some of these are quite difficult as the computer does not show you the maze, so you have to find your way through it blind. This game also produced some hilarity in our lab.

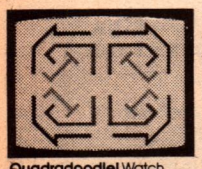
Videocart-11 provides two card games, Acey-Ducey and Backgammon. These are both two player games. Videocart-12 provides a baseball game, again for two players.

Other cartridges we were not able to try out provide additional games such as Torpedo Alley, Dodge It, Sonar Search and Robot War. No doubt even more games and quizzes will be made available in the near future.

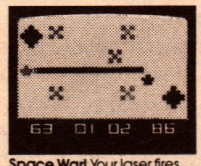
A VHF modulator is provided for interfacing the game to the colour TV set. A 75 ohm cable is provided for the connection. Either of two channels is selected by a small slide switch accessed on the underside of the case with a small screwdriver.

Our overall reaction to the Channel F video game system was one of enthusiasm. With the number of variations of each game, as well as the sheer number of games, it will obviously be a long while before all the thrill will go away from this game.

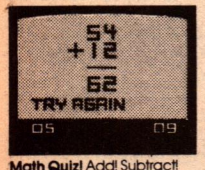
The Channel F Video Game and associated cartridges are available from Dick Smith Electronics, who have branches in most states. Recommended retail price of the game centre, which includes one cartridge, a 240V power pack, two hand controllers and the appropriate connecting leads is $269.00. Extra cartridges cost $24.50 each. (D.W.E.)



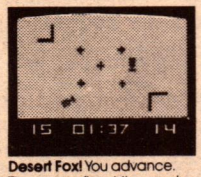
Quadradoodle! Watch your TV draw a kaleidoscope of color!



Space War! Your laser fires, but the other flying saucer ducks!



Math Quiz! Add! Subtract! Multiply! Divide! Fun for young players!



Desert Fox! You advance. The enemy fires, hits — and you're outfoxed!

Examples of the many games available on the Fairchild Video Entertainment System.

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Weller soldering station

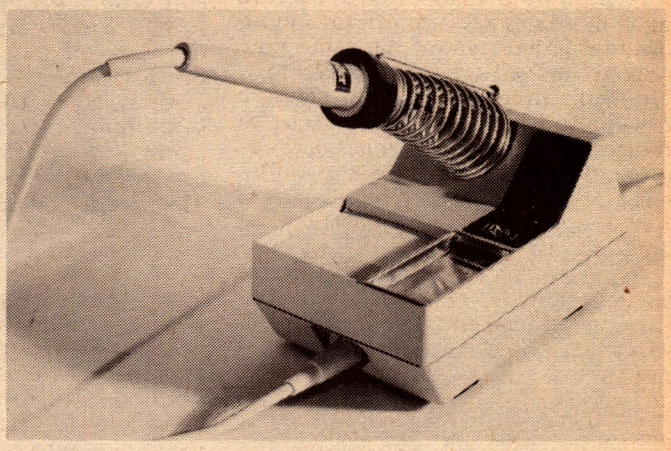
A new Weller soldering station has just been released on the Australian market. It features a low voltage, temperature cotrolled pencil-type soldering iron, powered from a stepdown transformer whose case functions as a versatile and attractive stand.

Control of the new Weller iron's tip temperature is achieved using a closed loop feedback method, utilising the change in magnetic properties of a special ferromagnetic sensor attached to the rear end of the tip. With a cold tip, this sensor attracts a permanent magnet, which switches on a heating element. Once the desired tip temperature has been reached, the sensor becomes non-magnetic, and the permanent magnet retracts and opens the element switch.

Different tip temperatures are achieved by changing the sensor, which in practice is an iegral part of the tip. Tips are available with temperatures of 315°C, 370°C and 430°C. A variety of tip shapes are availab,e including screwdriver, conical and single flat types.

All tips ar surface plated to prevent oxidation and corrosion, and to mimimise "solder creep" up the tip. The tip of the iron is electrically separate from the heating element, and is grounded via the power cord.

The iron runs from a 24V AC supply rated at 2A, which is supplied by the transformer in the stand. The iron is attached to the stand by a 1.2m cord, and normally rests in a spring stand with a bakelite sleeve to prevent heat loss.

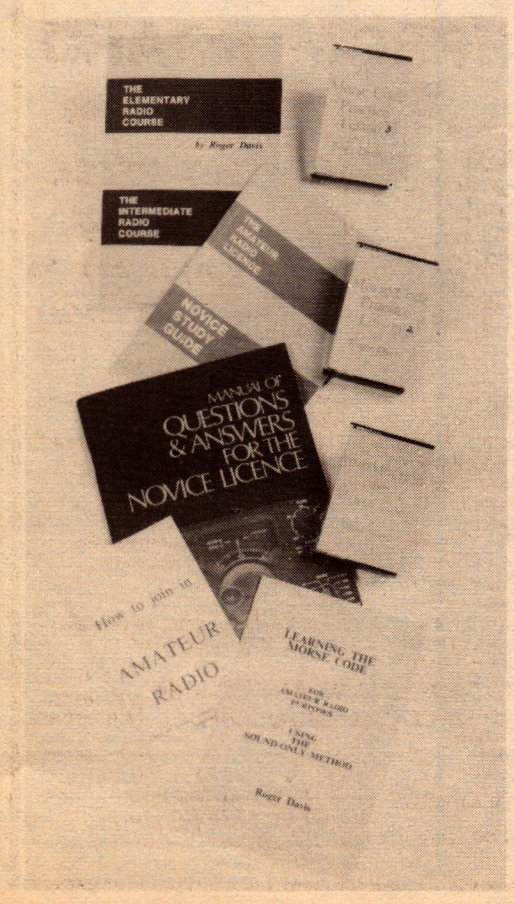


A tip wiping sponge is provided, as well as a metal tray for storing spare bits.

A rocker type on-off switch is provided on the stand, with a red neon indicator light. Overall dimensions of the stand are 113 x 187 x 92mm. The iron is quoted as recovering from a 56°C temperature drop in 11 seconds.

In practical use in our laboratory, we found the iron quite pleasant to use, although the end of the handle nearest the tip did tend to overheat a little. The iron was quick to recover from overloads, and seemed able to maintain the tip temperature at the specified level during all normal soldering.

Further details of the Weller WTCPN Soldering Station are available from radio Despatch Service, of 869 George Street, Sydney. Quote dprice is $54.00, and spare tips and other parts are readily available (DWE).



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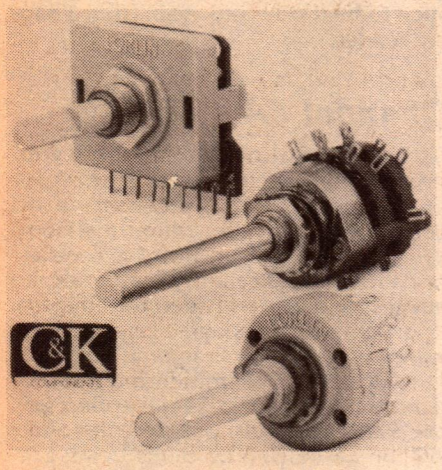
Economic pressures are forcing equipment designers to produce more flexible designs, yet at the same time reduce the required parts inventory. The Lorlin range of rotary switches are designed to contribute significantly to these goals, as all switches in the range are fitted with adjustable stops. This allows a small range of standard parts to be used for a wide variety of applications.

Available in the Lorlin range are three basic types of rotary switch. The economical type CK, dust resistant and of all glass filled nylon construction is available in 1, 2, 3 and 4-pole models with optional rear PCB mounting. Then there is the type RA, a professional quality multiple bank wafer switch with diecast body and quality glass-filled DAP wafers. Finally there is ths type PT, a PCB mounting switch of flame-retardant plastic which incorporates fibreglass wafers.



All switches are available ex stock from the Australian distributors for Lorlin, C & K Electronics (Aust.) Pty Ltd, 2/6 McFarlane St, Merrylands, NSW 2160. A free catalog is available.

Counter/marker

A digital frequency meter with in-built marker oscillator is available from Chirnside Electronics. The Model DX-555 is intended for radio amateurs and shortwave enthusiasts, and covers the frequency range from 10Hz to 220MHz.

The frequency counter section has 5-digit LED readout and two timebase ranges to give effective 7-digit display for higher frequencies. Input sensitivity is better than 20mV up to 30MHz.

The marker oscillator section is continuously tunable from 440kHz-30MHz in 3 bands. Output may be either CW or AM, with the frequency read by the counter section as required.

Price of the Model DX-555 is $218.00, including sales tax. Further details are available from Chirnside Electronics, 26 Edwards Rd, Lilydale Victoria 3140.

Industry Briefs

● Rifa Pty Ltd has recently appointed agents for their high quality range of components in South Australia, Western Australia and Queensland. The new agents are NS Electronics (46 3928) in SA, W.J. Moncrieff (325 5722) in WA, and Electronic Components (371 5677) in Qld.

● Soanar Electronics Pty Ltd is now distributing the IRH range of Australian made metal glaze resistors, available in ¼W, ½W and 1W sizes covering the range from 2.2 ohms to 1M. The firm is also distributing the Philips type BPX 47A silicon solar panel, which is capable of delivering 11 peak watts at 15.5V DC. Further details on both product lines are available from Soanar Electronics Pty Ltd at 30 Lexton Road, Box Hill, Victoria 3128.

● Dick Smith Electronics have produced a complete kit for the new Playmaster AM/FM tuner with digital readout and clock, as described in this issue. It is an exact match for the Playmaster Twin 25 and 40/40 amplifier kits produced by Dick Smith. Inexperienced constructors can attempt the kit with confidence as it contains a "Sorry Dick, it doesn't work" coupon. Priced at $159.50 (K.3493), the kit is available from all Dick Smith stores and dealers.

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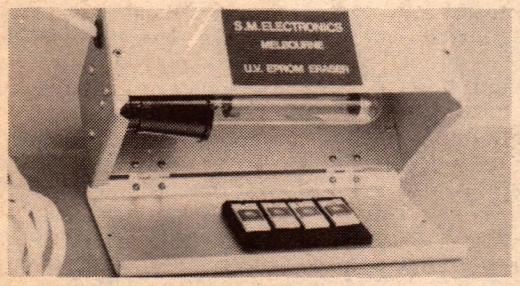

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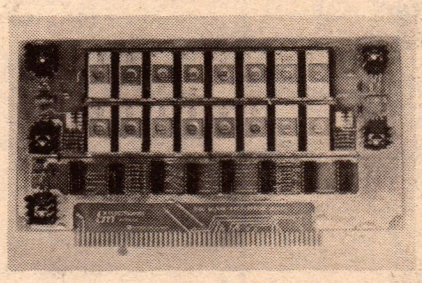

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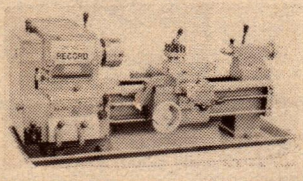

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Letters to the editor

A bouquet?

On reading the article by the Serviceman in the September issue, one is astonished by the person's intelligence, technical ability, tact, charm, eloquence and graciousness.

What a shameful waste of talent, most profound!

Obviously the Serviceman's yet unattained destiny is at a research institute or in the diplomatic corps.

J.A.
Prospect, NSW.

COMMENT: When we showed your letter to the Serviceman he muttered something about one leg being longer than the other, but agreed that the diplomatic corps would probably suit his special attributes best!

And another . . .

I thought I would just take the opportunity of writing to congratulate you on such a fine magazine as Electronics Australia. I started buying the magazine back in 1956 and have not missed an issue since. They are all bound in folders and form a most useful reference for me in the pursuit of my hobby and career. I have bought all the other electronics magazines at different periods of time, and yours stands head and shoulders above the rest, both in content as well as presentation. You achieve a good balance between theory, construction and information articles, in fact I don't think one could ask for more in such a publication. Your constructional type articles are well documented and tested and what's more they really work. In particular the articles on test equipment have been much appreciated, the 1966 VTVM and the 5in CRO rebuilt to modern standards are two items still giving excellent service in my workshop.

I enjoy the down to earth way and the sense of humour portrayed in the "Forum" and "Serviceman" articles, in fact I am enclosing a separate letter describing a very interesting intermittent fault I encountered recently and I would appreciate you passing it on to the serviceman for me.

In conclusion I would like to say thank you for a fine magazine, one which has helped me in many aspects, firstly in my career with Telecom, right from a trainee in 1956 up to my current position of Senior Technical Officer Grade 2, and secondly in widening my understanding of electronics to gain the AOLCP last year and the BOCP this June.

Philip Tazzyman,
Altona, Victoria

COMMENT: Our collective head just swelled markedly! Seriously though, it's nice to hear now and again from a happy reader.

Channel 5A

I must take strong exception to your editorial in September's issue. Your suggestion that amateur radio operators are crying wolf in relation to the channel 5A issue is not acceptable and there is certainly evidence to suggest that there is need for concern.

Around 10 years ago I operated a 2 metre station in Wollongong. With only a 10 watt AM transmitter, interference was caused to local TV reception and the Radio Inspector ordered me to stay off the air despite no faults being present in my transmitter.

If as you suggest there are no complaints of interference reported in the South Coast region, then perhaps one of the following may explain why:

1. Operation is restricted to 146MHz low power FM and 144MHz SSB DX operation is absent here.
2. The low part of 2 metres is useless due to "TV hash".
3. Amateurs in the area have given up! They are aware of problems so do not operate in a manner causing interference.

You may have noticed reference to tests carried out in Renmark, SA reported in the VHF notes of September "Amateur Radio" magazine. This showed that 2m SSB does affect Channel 5A.

In the north-west coast region of Tasmania VHF Amateurs are faced with a problem. The Wynyard 5A translator precludes the use of 2 metres SSB. Devenport has a proposed Channel 0

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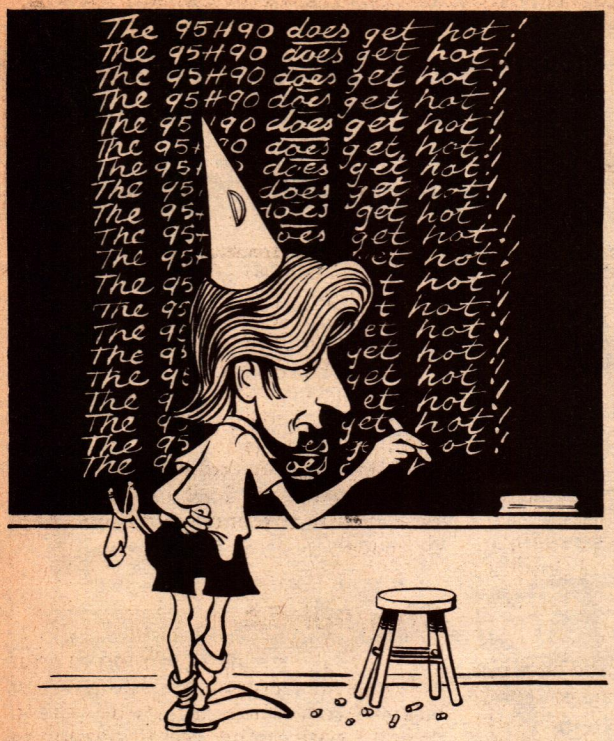

Luckily for Leo Simpson, corporal punishment has been abolished ... (See letter on "Project Troubles", below).

translator which has been clearly demonstrated to preclude the use of 6 metre SSB. What can a Z call use in this region?

It is clear that the attitude of your editorial won't help the amateur case. Despite your call, it seems that VK2XV is out of touch. Channel 5A does create problems and it must be the restraint of amateurs which is limited present problems.

UHF TV must come eventually. Why delay it?

J. Gelston, VK7JG
Launceston, Tasmania.

COMMENT: As pointed out in "Forum", our observations about the Wollongong area were based on observed fact. We did not accuse amateurs of crying wolf, but we warned that the authorities could reach that conclusion if amateurs did not support their case with documented data.

Project troubles

I found your "200MHz Frequency Counter" project very interesting, but I did not appreciate the "half cocked" manner in which it was presented.

For example: I found the 95H90 IC on my PCB getting quite hot. I took it to be faulty, threw it out. Then in the next issue of EA (Sept. '78) you remembered to tell us that it should run hot. I wish you had mentioned that in the first place, the 95H90 is quite expensive. This kind of thing is very annoying.

You told us in the original article that "any TTL IC can be replaced by low power schottky equivalent". I therefore used a 74LS73, and had a lot of trouble (it divided by 2 instead of 3). I tried another, same thing. Now in the October issue, you remember to say not to use Schottky in the timebase. Make up your mind, can't you? Don't say you can if it isn't true. Taking an IC off the board for the third time and replacing it for the third time makes the copper track disintegrate, spoils the whole project through your wholly unnecessary misleading statements.

Neither did I appreciate the error on the PCB diagram leaving out the earth connection to 7490A.

I wish you would get your facts right before publishing your projects and I wish you would publish the whole project in the one issue. To make up my losses I will stop buying EA for 12 months and read it at my local library instead.

John Wiseman,
Kew, Victoria.

COMMENT: Being human, we find it difficult not to err from time to time. If it is any consolation, the author of the project has been duly admonished.

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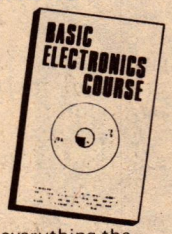

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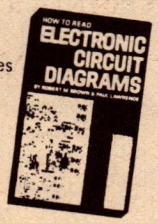

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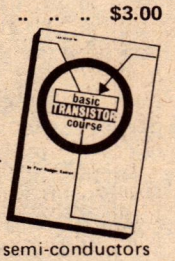

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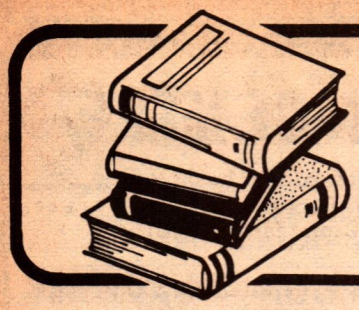

Books & Literature

Norton op-amps

IC LM3900 PROJECTS, by H. Kybett, B.Sc. Bernard Babani (Publishing) Ltd, London, 1978. Soft covers, 106 x 179mm, 119pp, many diagrams. Price in UK £1.35.

As the title suggests, this is a down-to-earth introduction to the versatile LM3900 Norton op-amp device, written for the technician, experimenter and hobbyist. The emphasis is on practical circuits, and how to design them for a given task. The text is a little rough in places, and there is evidence of inadequate proof reading. Similarly some of the diagrams seem insufficiently labelled. However on the whole it seems a useful little book, and good value for money at the modest price level involved.

The review copy came direct from the publisher. (J.R.)

ICs in radio

RADIO CIRCUITS USING IC's, by J. B. Dance. Published 1978 by Bernard Babani (Publishing) Ltd. Stiff paper covers, 128 pages 181mm x 109mm, illustrated by circuits and diagrams. No price quoted.

The author of this little book, J. B. (Brian) Dance, will be well known to readers as a regular contributor to "Electronics Australia". His new "Radio Circuits Using IC's" has been written primarily for those who like to fiddle with circuits and components, as distinct from the prevailing modern tendency to buy a kit and assemble it as per instructions.

Chapter 1 provides an introduction to integrated circuits; the concept, packages and sockets, constructional hints and associated hardware such as PC boards, etc.

Chapters 2 and 3 deal with AM and FM receivers respectively, with the AM receivers tending towards the elementary and FM, of necessity, towards much more complicated circuitry. The practical value of these two chapters to Australian readers would depend largely on the prospective constructor being able to locate the necessary bits and pieces.

ICs developed for stereo and quadraphonic decoding provide the basis for chapter 3, while the final chapter is devoted to voltage regulator circuits of one kind and another. As we suggested: a book which will be appreciated most by the dedicated experimenter.

Our copy came direct from the publisher (W.N.W.).

Basic recording

BEGINNER'S GUIDE TO TAPE RECORDING by Ian R. Sinclair. Stiff paper covers, 167 pages, 186mm x 120mm, illustrated by diagrams. Published by Newnes/Butterworths, London. Price in Australia $8.00.

This is one of a series of "Beginner's Guide To ..." books published by Newnes/Butterworths and one of several titles by Ian Sinclair. And like other books by Sinclair, it appears to have been well planned and carefully edited. Sample reading of the text revealed no hassles and it should therefore be a very useful book for anyone wanting to round out their knowledge of tape recording technology.

It starts with the fundamentals of sound and magnetism — the two key topics. Thereafter follow chapters on Microphones — Development of tape

recording — Mechanical systems - Tape and recording — Electronics systems — Noise reduction — Using the tape recorder — More advanced techniques — Index.

Under "Using the tape recorder" Ian Sinclair talks about the choice and use of microphones, recording from radio and disc, tape dubbing, monitoring and so on. "More Advanced techniques" has to do with mixing, splicing, editing, multi-tracking and other tricks of the trade. In all, a commendable effort.

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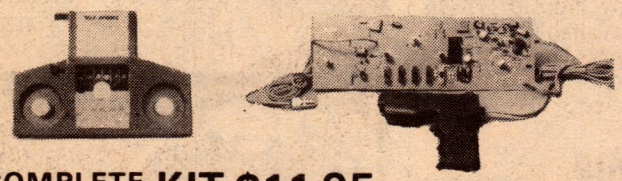

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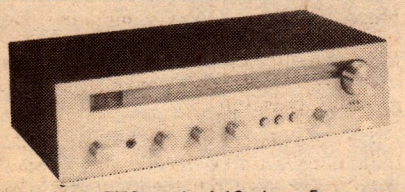

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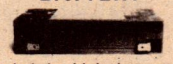

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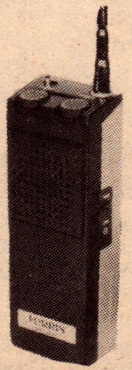

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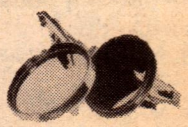

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PLAYMASTER FM/AM TUNER . . . from page 47

The 30mm knob for tuning is machined to fit a 6.35mm shaft (¼-inch) but the shaft of the tuning gang is only 6mm. The slack can be taken out with a shim of brass or, as in our case, with a piece of graphic arts film. If this is not done the knob will wobble.

Next month, we shall feature a trouble shooting procedure and a table indicating the diodes needed for programming the FM offset, which may be required. We shall also publish the PCB patterns and other relevant data.

Information Centre

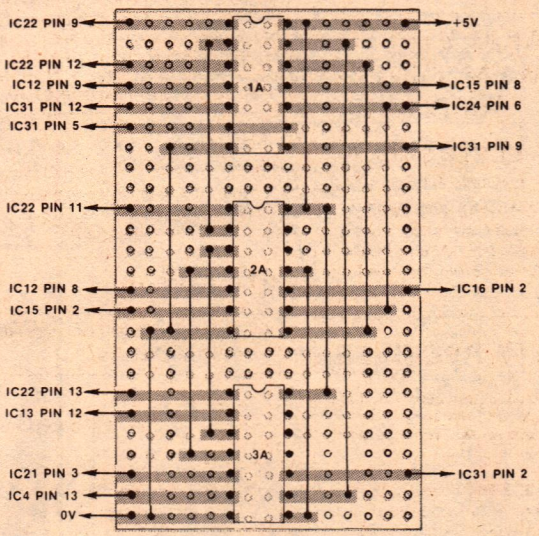
Due to lack of space it has not been possible to include the Information Centre column in this issue. Space permitting, it will appear again next month, to provide answers to your technical queries. Send your requests to the Assistant Editor, EA, Box 163, Beaconsfield 2014.

NOTES & ERRATA

DELTAHET Mk II (February, March, April, May 1971, File Nos 2/SW/57, 58, 59, 60): We understand that Ducon are no longer making their line of ferrite toroid coil formers. The Ducon Q2 material type F4040/2 formers used for the RF stage of the Deltahet Mk II may be replaced by a near equivalent, type 4329R/2/F25, made by Neosid. These should normally be available through Watkin Wynne in Sydney. It may be necessary to change one or more of the series and parallel capacitors associated with these coils.

COMPUTER TAPE INTERFACE (April 1977, File No. 2/CC/19). It has been brought to our attention that the time constant of the RC circuit coupling the off-tape signal into T6 is too low, and can cause errors during replay. A cure can be effected by increasing the 0.1uF input coupling capacitor in T6's base circuit to 0.47uF.

IMPROVED DECODING FOR LOW COST VDU (October 1978, File No. 2/CC/31). Due to a delay in receiving revised diagrams from the author, we inadvertently published incorrect circuit and wiring diagrams. The corrected diagrams are reproduced at right and below. Note also that the circuiry of Fig. 1 converts all lower case characters to their upper case equivalents, and not just the letter "A".



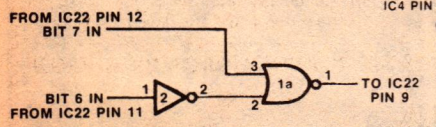


FIG. 1 CUT TRACK IC22 PIN 9 TO 11

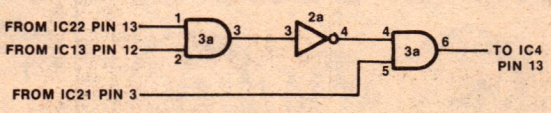
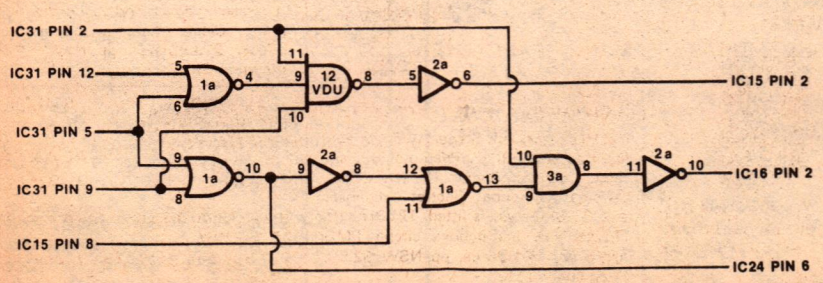


FIG. 2 CUT TRACK IC21 PIN 3 TO IC4 PIN 13



CUT TRACKS FROM IC15 PIN 8 TO IC16 PIN 2
FROM IC15 PIN 1 TO IC15 PIN 2
FROM IC24 PIN 5 TO IC24 PIN 6

ADD LINKS FROM IC31 PIN 2 TO IC12 PIN 11
FROM IC31 PIN 9 TO IC12 PIN 10

FIG. 3

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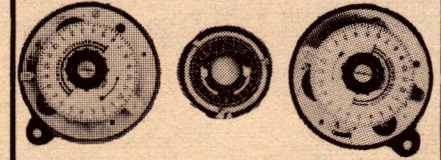

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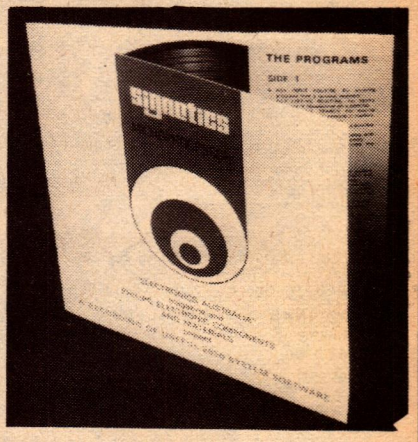

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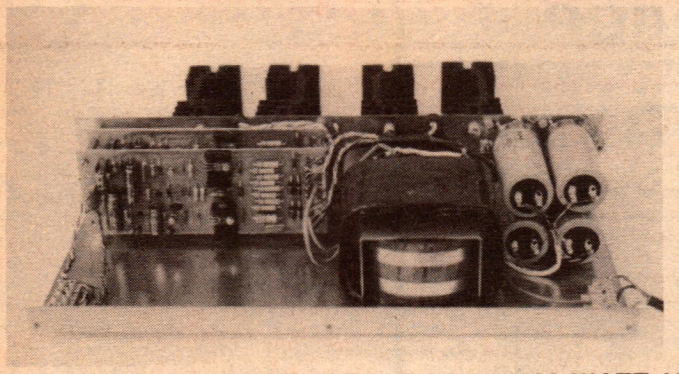

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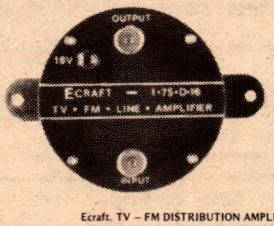

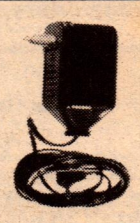

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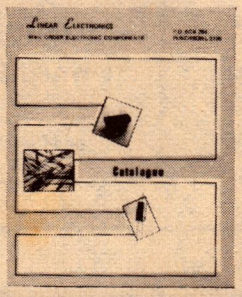

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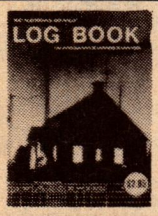

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